FINAL REPORT

Record of Decision

Operable Unit 3/ Installation Restoration Program Site 21

Hanscom Air Force Base Massachusetts

Prepared for

HQ AFCEE/ERD

Brooks AFB, TX 78235-5328

October 2001

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13. ABSTRACT ***(Maximum 200 words)***

This report presents the Final Record of Decision for Hanscom AFB, Massachusetts Operable Unit 3/ IRP Site 21. The Final Record of Decision summarizes the phases of site investigation, human health and ecological risk assessments, and Feasibility Study and presents the selected alternative for remedial action to address contamination risk at the site.

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Acronyms

AFB	Air Force Base
ARAR	Applicable or Relevant Appropriate Requirement
AST	Aboveground Storage Tank
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Act Information System
cfs	Cubic feet per second
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CSM	Conceptual Site Model
DoD	Department of Defense
EE/CA	Engineering Evaluation/Cost Analysis
ERA	Ecological Risk Assessment
ESC	Electronics Systems Center
FAA	Federal Aviation Administration
FFA	Federal Facility Agreement
FS	Feasibility Study
GAC	Granular Activated Carbon
GFL	Glaciofluvial and Glaciolacustrine
gpm	gallons per minute
HHRA	Human Health Risk Assessment

HI	Hazard Index
HQ	Hazard Quotient
IC	Instrumentational Controls
IROD	Interim Record of Decision
IRP	Installation Restoration Program
LNAPL	Light Non-Aqueous Phase Liquid
LUC	Land Use Controls
MADEP	Massachusetts Department of Environmental Protection
MASSPORT	Massachusetts Port Authority
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goals
MCP	Massachusetts Contingency Plan
mgd	million gallons per day
MSL	mean sea level
NCP	National Oil and Hazardous Substances Contingency Plan
NFRAP	No Further Response Action Planned
NPL	National Priorities List
O&M	Operation and Maintenance
ORC	Oxygen Release Compound
OSRR	Office of Site Remediation and Restoration
OU	Operable Unit
PAH	Polynuclear Aromatic Hydrocarbon
PPE	Personal Protective Equipment
PRG	Preliminary Remediation Goal

RAB	Restoration Advisory Board
RAO	Remedial Action Objectives
RfD	Reference Dose
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
PPE	Personal Protective Equipment
SARA	Superfund Amendments and Reauthorization Act
SVE	Soil Vapor Extraction
SVOC	Semi-volatile organic compound
TMDL	Total Maximum Daily Loads
TPH	Total Petroleum Hydrocarbon
TTCU	Time to Clean Up
TRC	Technical Review Committee
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
VER	Vapor Enhanced Recovery
VOC	Volatile organic compound

1.0 Declaration for the Record of Decision

Hanscom Field/ Hanscom Air Force Base
CERCLIS ID#: MA8570024424
Operable Unit 3/Installation Restoration Program Site 21
Bedford, Massachusetts

1.1 Statement of Basis and Purpose

This decision document presents the selected remedial action for Operable Unit 3/ Installation Restoration Program Site 21 (OU-3/IRP Site 21), at Hanscom Air Force Base (AFB). This remedial action was selected in accordance with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), 42 USC § 9601 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR Part 300 et seq., as amended. The Air Force Material Command Vice Commander has been delegated the authority to sign this Record of Decision (ROD) for the U.S. Air Force and the Director of the Office of Site Remediation and Restoration (OSRR) has been delegated the authority to sign this ROD for the U.S. Environmental Protection Agency.

This decision was based on the Administrative Record, which has been developed in accordance with Section 113 (k) of CERCLA, and which is available for review at the Hanscom AFB Environmental Flight Office located at 72 Dow Street, Hanscom AFB, Massachusetts. The Administrative Record Index (Appendix A to the ROD) identifies each of the items comprising the Administrative Record upon which the selection of the remedial action is based.

The Commonwealth of Massachusetts, through the Massachusetts Department of Environmental Protection (MADEP), and U.S. Environmental Protection Agency Region I concur with the selected remedy.

1.2 Assessment of the Site

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

1.3 Description of the Selected Remedy

This ROD sets forth the selected remedy for OU-3/IRP Site 21 at the Hanscom AFB. The selected remedy involves:

- Three (3) interceptor trenches with passive recovery wells, one main trench covering light non-aqueous phase liquid (LNAPL) Pools A and B near the northern boundary of the site, and two smaller trenches at hotspot areas within LNAPL Pool C (see Section 2.5.2.1 for a description of the different LNAPL Pools);

- Network of enhanced recovery wells in non-hotspot areas of LNAPL Pool C connected to an existing on-site oil-water separator and groundwater treatment system;
- Enhancement of biodegradation of dissolved-phased contaminants (volatile organic compound (VOCs) and fuel compounds) by the application of Oxygen Release Compound® (ORC®) in all trenches;
- Groundwater and LNAPL Monitoring;
- Land Use Controls/Institutional Controls; and
- Groundwater Containment/Treatment and Vapor Enhanced Recovery (VER) Contingencies;
- Five-year reviews.

The interceptor trenches and recovery wells provide the means to contain/capture the site's LNAPL and dissolved-phase groundwater contaminants (VOCs and fuel compounds), and the monitoring will confirm that the groundwater contaminant plume is being remediated and/or contained and is not adversely impacting the Shawsheen River. A by-product of the trench construction will be the removal and disposal (recycled either off-site or on-site) of petroleum saturated soil. Also the ORC® can be easily applied during construction of the trenches. In addition, the land use controls/institutional controls (LUCs/ICs) will ensure that groundwater is not used for human consumption and that future land use does not increase the risk of exposure to contaminants remaining on site.

Due to the nature and extent of the contaminants, the current and future land use, and since IRP Site 21 is totally on an active Air Force Installation LUCs/ICs in terms of administrative mechanisms are considered acceptable measures to control exposure to on-site LNAPL and contaminated groundwater. The IRP Site 21LUCs/ICs will be implemented and enforced by Hanscom AFB in accordance with Air Force Instructions. LUCs/ICs have already been partially instituted in that IRP Site 21 is shown in the Hanscom Air Force Base General Plan (master plan) as an area of the base with "Environmental Constraints" and base operating procedures as defined by Air Force Instructions requires that project planning documents (for both new construction and repair projects) be coordinated with the environmental office. Also groundwater from OU-3/IRP Site 21, or from anywhere else on Hanscom AFB, is not used as a water supply and is not expected to be used as a water supply anytime in the future. These LUCs/ICs will be enhanced by amending the General Plan to add the specific environmental constraints (LUCs/ICs) that apply to IRP Site 21 site and by issuing periodic Memorandums to Hanscom AFB project originators emphasizing the Air Force's requirement that project planning documents (for both new construction and repair projects) be coordinated with the environmental office. LUCs/ICs will be formally monitored and results documented by the base environmental office in normal operations, maintenance, and/or monitoring reports. In addition five-year reviews will be conducted by the Air Force in accordance with EPA guidance to assure that the remedy provides adequate protection of human health and the environment whilst contaminants remain on-site above levels which allow unrestricted exposure and unlimited use.

Groundwater Containment/Treatment and VER Contingencies include provisions in the design/installation of the associated passive product recovery wells in the interceptor trenches for use for groundwater containment (pump and treat) or as a mechanism for the establishment of an ORC® treatment barrier if downgradient groundwater monitoring indicates contamination may adversely impact the Shawsheen River. Provisions will also be included in the design/installation of the enhanced product recovery wells within LNAPL Pool C so they could be used for vacuum enhanced product recovery if needed.

The selected remedy addresses current and potential future risks caused by groundwater and LNAPL contamination at OU-3/IRP Site 21. Remedial actions have already been conducted at OU-3/IRP Site 21 (these actions are summarized in Section 2.2). The nature of contamination at OU-3/IRP Site 21 includes dissolved-phase VOCs and fuel compounds and residual LNAPL acting as a continuing source of groundwater contamination. Principal chemicals of concern include benzene, vinyl chloride, and 1,4-dichlorobenzene in groundwater. The contamination is a result of the historical storage and transfer of fuel, solvents and other petroleum products at the site. Low-level threat wastes that this ROD addresses include human contact with the petroleum product and groundwater contaminated with VOCs through ingestion, inhalation and dermal contact. Refer to Section 2.4, *Scope and Role of Response Action*, for a definition of low-level and principal threat wastes.

The primary objectives of the remedial measures – product removal and the treatment of dissolved-phase groundwater combined with land use controls/institutional controls and monitoring – are to prevent the migration of contaminants from the product to the groundwater, prevent migration of VOC contaminated groundwater to surface water bodies, and prevent human exposure to groundwater above health-based criteria via ingestion, inhalation and dermal contact. The ultimate objective is to return the site's groundwater to drinking water standards. Several contingencies have been built into the remedial action such as the ability to contain or treat dissolved-phase groundwater and to enhance LNAPL recovery through the use of VER systems. The need to implement the contingencies will be based on monitoring and an evaluation of system performance.

The selected response action described above addresses principal threat wastes at OU-3/IRP Site 21. There are no low-level threat wastes present at OU-3/IRP Site 21.

1.4 Statutory Determinations

The selected remedy is protective of human health and the environment, complies with Federal and State requirements that are applicable or relevant and appropriate to the remedial action (unless justified by a waiver), is cost-effective, and utilizes permanent solutions and alternative treatment technologies (application of ORC®) to the maximum extent practicable. This remedy also satisfies the statutory preference for treatment as a principal element of the remedy.

Because this remedy will result in hazardous substances remaining on-site above levels that allow unrestricted exposure and unlimited use, and groundwater and land use restrictions are necessary, a review will be conducted to ensure that the remedy continues to provide adequate protection of human health and the environment each five years after initiation of the remedial action.

1.5 ROD Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for this site.

1. Chemicals of concern (COCs) and their respective concentrations
2. Baseline risk represented by the COCs
3. Cleanup levels established for COCs and the basis for the levels
4. Current and future land and ground-water use assumptions used in the baseline risk assessment
5. Land and groundwater use that will be available at the site as a result of the selected remedy
6. Estimated capital, operation and maintenance (O&M), and total present worth costs; discount rate; and the number of years over which the remedy cost estimates are projected
7. Decisive factor(s) that led to selecting the remedy.

1.6 Authorizing Signatures

This ROD documents the selected remedy for groundwater, including the LNAPL floating on the groundwater, at OU-3/IRP Site 21 at Hanscom AFB. The USAF selected this remedy with concurrence of the U.S. Environmental Protection Agency and the Massachusetts Department of Environmental Protection.

United States Air Force

By: Charles H Coolidge Jr Date: 20 August 2002

CHARLES H. COOLIDGE, JR.
Lieutenant General, USAF
Vice Commander
Air Force Materiel Command

United States Environmental Protection Agency

By: Stanley D Chen for RC DATE: 8/29/02

RICHARD CAVAGNERO
Acting Division Director
Office of Site Remediation and Restoration
Region 1

2.0 Decision Summary

2.1 Site Name, Location and Brief Description

2.1.1 Name and Location

Hanscom Field/Hanscom AFB – This site is located in Middlesex County, Massachusetts, approximately 14 miles northwest of downtown Boston and includes land in the towns of Bedford, Concord, Lexington, and Lincoln, Massachusetts. The OU-3/IRP Site 21 area, addressed in this ROD, encompasses approximately 7.5 acres in the Town of Bedford that is located in the northeast corner of Hanscom AFB, south of Hanscom Field. The Shawsheen River forms the northern boundary of the site (Figure 2-1).

2.1.2 Comprehensive Environmental Response, Compensation, and Liability Act Information System Identification Number

The Comprehensive Environmental Response, Compensation and Liability Act Information System (CERCLIS) identification number for Hanscom Field/ Hanscom AFB is CERCLIS ID# MA8570024424.

2.1.3 Lead Agency

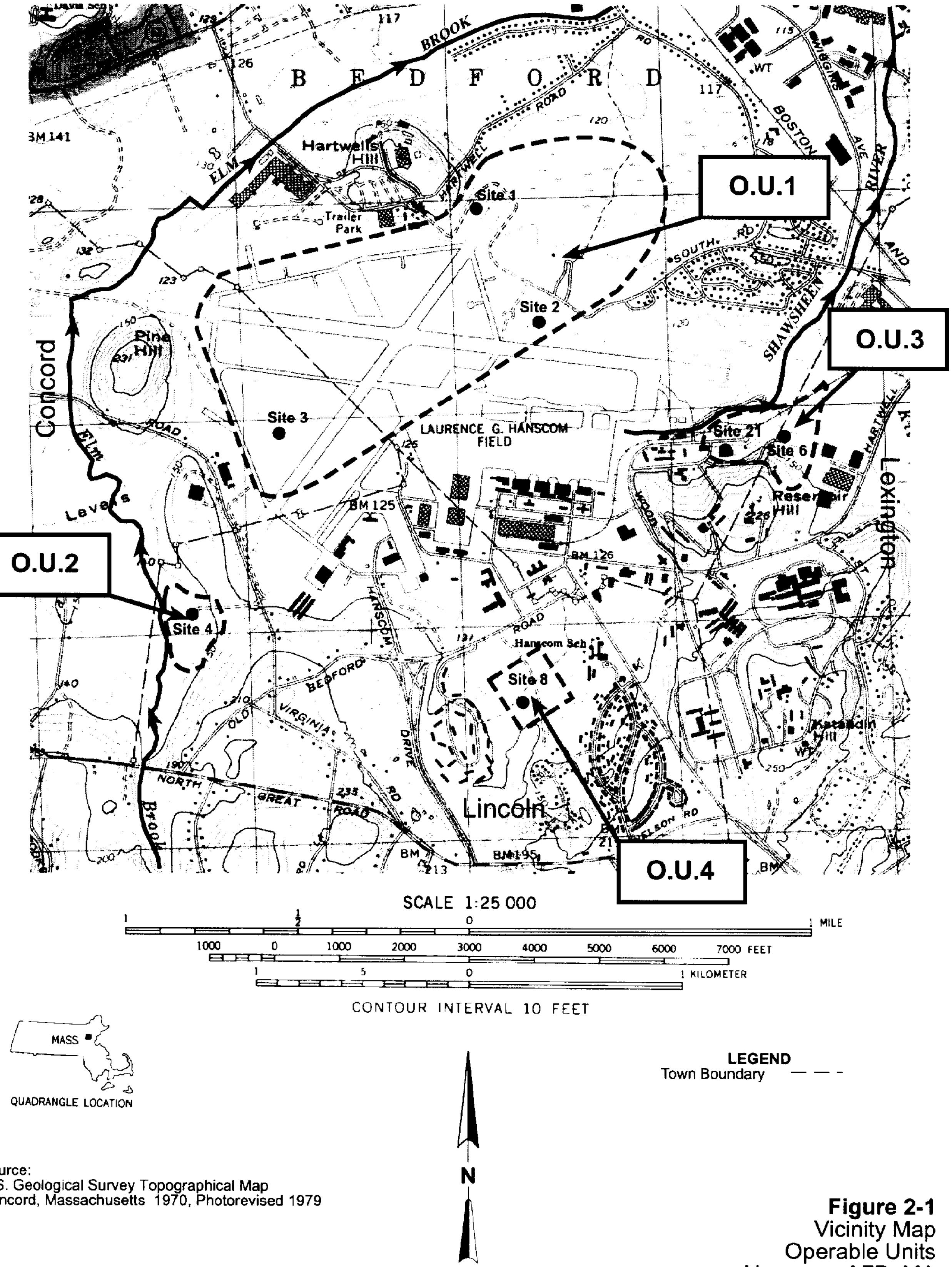
The USAF is the lead agency with regulatory oversight from USEPA (lead) and the MADEP (support).

2.1.4 Site Description

Hanscom AFB is an active base owned and operated by the Federal government through the Department of the USAF. Hanscom AFB is home to the Electronics Systems Center (ESC), a dynamic nucleus of research and development. ESC is the USAF acquisition and development center for world-class command and control systems.

Hanscom Field, located adjacent to and north of the Base, is a civilian airport owned by the Commonwealth of Massachusetts and operated by Massachusetts Port Authority (MASSPORT) and the Federal Aviation Administration (FAA). However, Hanscom Field was used as a military airport by the Air Force from 1942 to 1973.

Topographically, Hanscom AFB is located in a low-lying basin surrounded by hills. The relatively flat runway portion of Hanscom Field lies in the ancient lake bed of glacial lake Concord. The ground surface elevation on this former lake bed ranges from 120 to 130 feet above mean sea level (MSL). The hills south of the air base, and Pine Hill to the west, rise to more than 200 feet MSL. Hills north of the airfield area are more subdued, but still rise above 150 feet MSL. Former Glacial Lake Concord, and Hanscom AFB on its southern edge, drain to the Shawsheen River, which flows north-northeast from the site to join the Merrimack River approximately 15 miles downstream.



Source:
U.S. Geological Survey Topographical Map
Concord, Massachusetts 1970, Photorevised 1979

Figure 2-1
Vicinity Map
Operable Units
Hanscom AFB, MA

CH2MHILL

The Department of Defense (DoD) initiated its IRP concurrently with CERCLA (as amended by SARA) with the overall goal of cleaning up contamination on DoD installations. The USAF began implementing the IRP at Hanscom AFB during the 1980s with initial surveys and records reviews to identify potentially contaminated sites. Hanscom AFB, including Hanscom Field, was listed on the USEPA National Priorities List (NPL) in 1994. Of the 22 individual IRP sites with known or suspected contamination, 7 have been designated as CERCLA sites and fall under jurisdiction of the USEPA. The CERCLA sites were grouped into four operable units, defined as follows:

Operable Unit 1

- IRP Site 1: Fire Training Area II
- IRP Site 2: Paint Waste Disposal Area
- IRP Site 3: Jet Fuel Residue/Tank Sludge Disposal Area

Operable Unit 2

- IRP Site 4: Sanitary Landfill

Operable Unit 3

- IRP Site 6: Landfill/Former Filter Beds
- IRP Site 21: Unit 1 Petroleum Release Site

Operable Unit 4

- IRP Site 8: Scott Circle Landfill

The location of the four Operable Units is shown in Figure 2-1. A more complete description of the site can be found in the OU-3/IRP Site 21 Feasibility Study, Section 1.3 – Background Information (CH2M HILL, June 2001).

2.2 Site History and Enforcement Activities

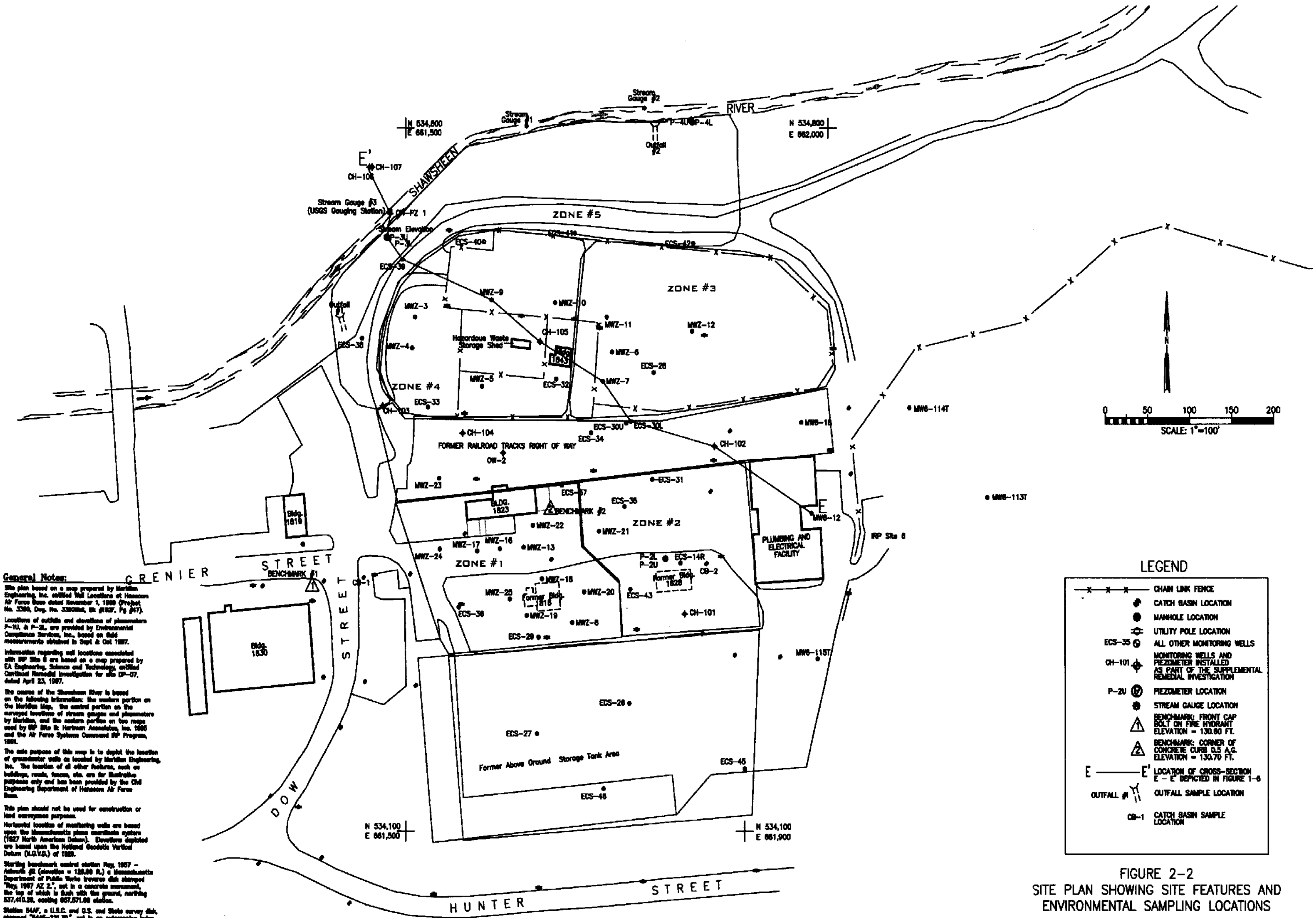
2.2.1 History of Site Activities

Prior to 1973, Hanscom AFB leased the runways and flight line, that is now Hanscom Field, from the Commonwealth and the primary mission of Hanscom AFB was the operational maintenance of fighter aircraft and research and development support.

IRP Site 21 consists of a former fueling facility that was used for storage, off-loading, and dispensing of jet fuel and aviation gasoline from at least 1945 through 1973, and to store and distribute No. 2 fuel oil during the early 1970s. Fuel was stored in aboveground and underground storage tanks, which had an associated network of piping. This area was also used for the storage of cleaning solvents and other petroleum products (oils and lubricants) associated with aircraft and vehicle maintenance.

In previous investigative efforts by the USAF, OU-3/IRP Site 21 was subdivided into seven areas. The seven areas, shown on Figure 2-2, are described as follows:

- Zone 1 which was formerly the location of a fuel transfer pump house (Building 1818) and truck loading facilities;



General Notes:

Site plan based on a map prepared by Meridian Engineering, Inc. entitled Well Locations at Hanscom Air Force Base dated November 1, 1988 (Project No. 3380, Dwg. No. 3380Well, Bk #182F, Pg #47).

Locations of outfalls and elevations of piezometers P-1U, & P-3L, are provided by Environmental Compliance Services, Inc., based on field measurements obtained in Sept & Oct 1997.

Information regarding well locations associated with IRP Site 8 are based on a map prepared by EA Engineering, Science and Technology, entitled Continued Remedial Investigation for site DP-07, dated April 23, 1997.

The course of the Shawsheen River is based on the following information: the western portion on the Meridian Map, the central portion on the surveyed locations of stream gauges and piezometers by Meridian, and the eastern portion on two maps used by IRP Site 8: Hartman Associates, Inc. 1985 and the Air Force Systems Command IRP Program, 1991.

The sole purpose of this map is to depict the location of groundwater wells as located by Meridian Engineering, Inc. The location of all other features, such as buildings, roads, fences, etc. are for illustrative purposes only and has been provided by the Civil Engineering Department of Hanscom Air Force Base.

This plan should not be used for construction or land conveyance purposes.

Horizontal location of monitoring wells are based upon the Massachusetts plane coordinate system (1927 North American Datum). Elevations depicted are based upon the National Geodetic Vertical Datum (N.G.V.D.) of 1929.

Starting benchmark control station Rey. 1957 - Azimuth #2 (elevation = 128.96 ft.) a Massachusetts Department of Public Works traverse disk stamped "Rey. 1957 AZ 2.", set in a concrete monument, the top of which is flush with the ground, northing 537,410.28, easting 657,571.86 station.

Station 54AF, a U.S.C. and G.S. and State survey disk, stamped "54AF-231.30", set in an outcropping ledge northing 537,908.30, and easting 657,003.70.

Starting benchmark station Rey. 1957 Azimuth #2 elevation equal to 128.96.

Starting benchmark station 54AO elevation equal to 218.530 ft.

Starting benchmark station ARP 1963 elevation equal to 128.489 ft.

07/19/01 CAD/160423/FIGURE2-2.DWG

FIGURE 2-2
SITE PLAN SHOWING SITE FEATURES AND ENVIRONMENTAL SAMPLING LOCATIONS
IRP SITE 21
HANSCOM AIR FORCE BASE
BEDFORD, MASSACHUSETTS

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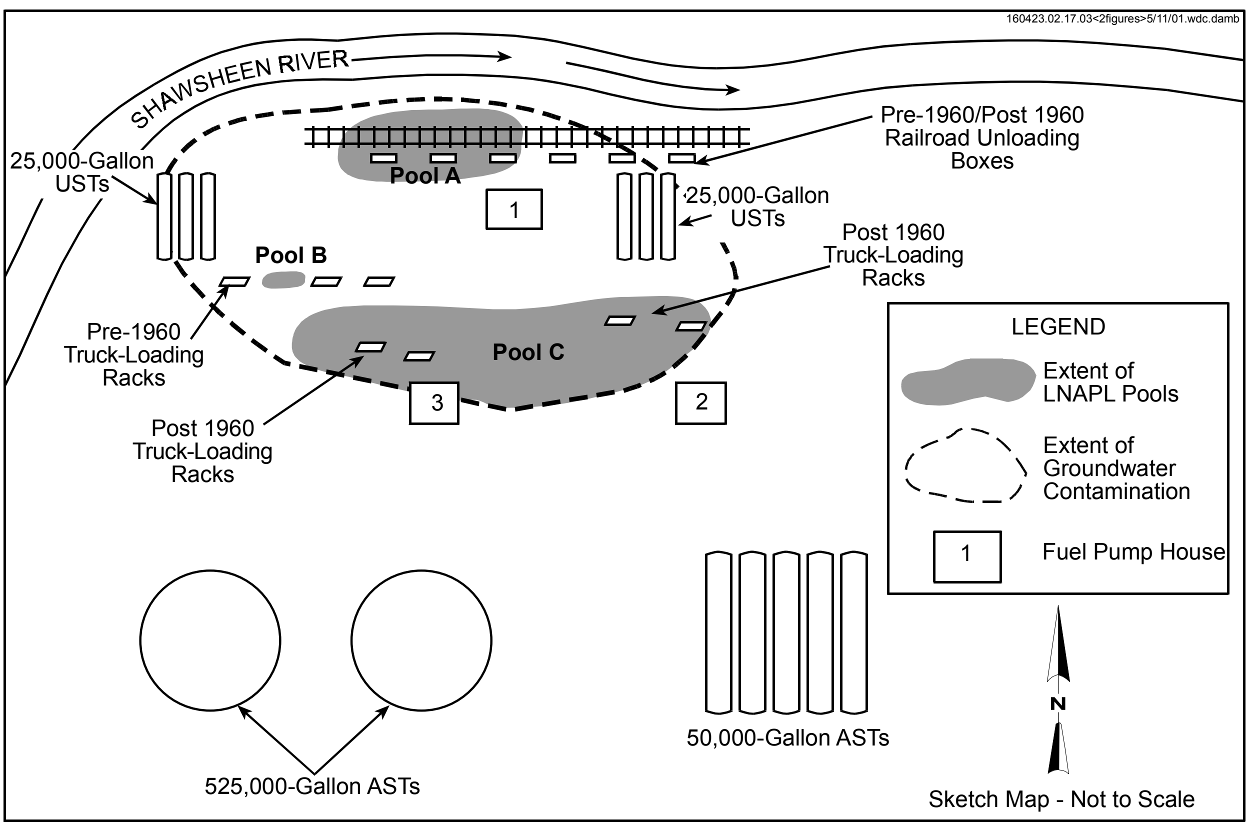
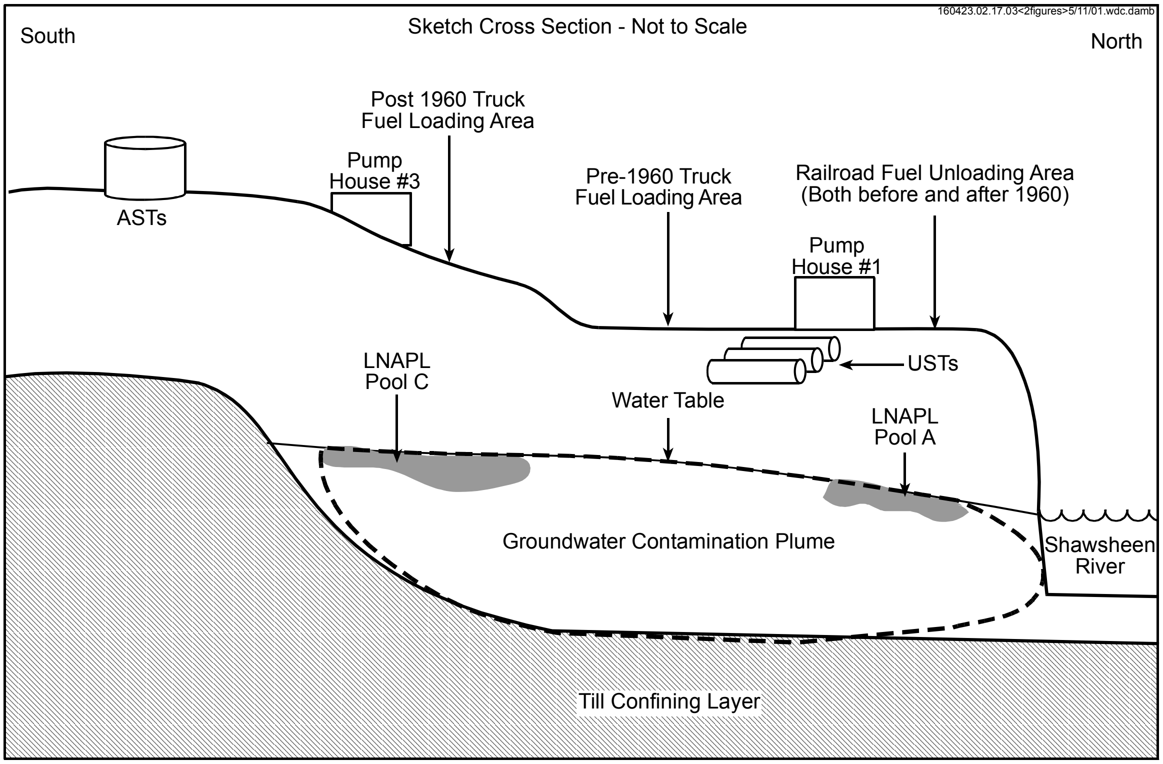
- Zone 2 which was formerly the location of a fuel transfer pump house (Building 1828) and truck loading facilities;
- Zone 3 which was formerly the location of railroad fuel unloading facilities and underground storage tanks;
- Zone 4 which currently includes Building 1843 (former fuel transfer pump house), and formerly the location of railroad fuel unloading and truck loading facilities and underground storage tanks;
- Zone 5 which borders the Shawsheen River;
- Former Aboveground Storage Tank (AST) area; and
- Former Railroad Right-of-Way.

The diagrams below present the historical layout of the site and a cross section of the subsurface. Prior to 1960 the fuel distribution and storage system at OU-3/IRP Site 21 consisted of a railroad tank car siding where the fuel was unloaded, six 25,000-gallon underground storage tanks (USTs), and truck loading/unloading stations located on the northern portion of the site (Zones 3 and 4 described above). Post-1960 the USTs and the truck loading/unloading stations were replaced by two 525,000-gallon jet fuel and five 50,000-gallon aviation gasoline above-ground storage tanks (ASTs) and new truck loading/unloading stations located on the south side of the site (Zones 1 and 2 described above). This system also included three pump houses (#1, #2 & #3 in diagram below).





A more complete description of the site history can be found in the Remedial Investigation Report, Section 1.3 – Site Background (ECS, April 1999) and in the Supplemental Remedial Investigation Report, Section 1.2 – Site Background and History (CH2M HILL, July 2000).

2.2.2 History of Federal and State Investigations and Removal and Remedial Actions

The DoD/USAF is the responsible party for OU-3/IRP Site 21. The DoD initiated its IRP concurrently with the CERCLA (as amended by SARA) with the overall goal of cleaning up contamination on installations. The USAF began implementing the IRP at Hanscom Field/Hanscom AFB in 1982 when Roy F. Weston, Inc. was retained by Hanscom AFB to conduct a hydrogeologic investigation at Hanscom Field to assess the potential for water quality degradation at the Town of Bedford's Hartwell Road wellfield as related to past waste disposal activities at Hanscom field. In 1984, JRB Associates, Inc. was retained by Hanscom AFB to complete an Installation Assessment/Records Search. The purpose of this investigation was to identify the potential for environmental contamination from past waste management practices, evaluate the probability of contaminant migration, and assess the potential hazard posed by past disposal activities. This effort identified 13 specific sites to be included in the restoration program. Subsequent discoveries, including IRP Site 21 in 1990 (the subject of this ROD), have increased the number of IRP sites to 22.

In June 1990 petroleum product identified as jet fuel (JP-4) was found in a foundation investigation boring for an addition to Building 1823 and in September 1990, during the cleaning of the abandon fuel transfer pipeline, No. 2 fuel oil was released from the end of the former rail tank car unloading header. Also, in December 1990 during the removal of abandoned underground tanks connected to the floor drains of the pump houses (Buildings 1818 and 1828), LNAPL was found in both of the UST excavations. Subsequently, the former fuel facility was designated IRP Site 21 and the MA DEP issued a Notice of Responsibility. Zenone, Inc. was retained by Hanscom AFB to conduct investigations and to design, install and operate an Interim Measure for the site. The Preliminary Remedial Investigation was conducted in October and November 1992 and the Interim Measure was operated from 25 March through 15 December 1993 (see Section 2.2.2.1 for further information on the Interim Measure). The above investigation and Interim Measure were conducted under the Air Force initiated CERCLA based IRP with the MA DEP as the lead regulatory agency.

A RI was completed for OU-3/IRP Site 21 by ECS in September 1998 (report finalized April, 1999). In addition, a Supplemental RI (CH2M HILL, 2000) was performed in 1999/2000 that was designed to address data gaps that were identified in the ECS RI. The Supplemental RI Report also presented the results of the OU-3/IRP Site 21 human health and ecological risk assessment. The studies and investigations conducted at OU-3/IRP Site 21 are summarized in Table 2-1 below.

2.2.2.1 Historical Remedial Actions at Site 21

In January 1991, a passive product recovery system was installed in one recovery well at OU-3/IRP Site 21. This recovery well was located beneath what is now the east wing of Building 1823 (Zone 1). This system which consisted of a submersible product recovery pump with controls operated continuously for approximately eight weeks and recovered a total of 25 gallons of product identified as jet fuel. This system is no longer in operation at OU-3/IRP Site 21.

In 1993, three horizontal recovery trenches with 12-inch slotted piping 18 feet below the ground surface were installed in the vicinity of Building 1818 (Zone 1) for the collection of groundwater and free product. 1,400 tons of petroleum-contaminated soil were removed during the excavation and were shipped to an off-site recycling facility. Each trench had a sump with a total-fluids pump. Recovered groundwater and product was pumped to an oil-water separator and then through granulated activated carbon (GAC) canisters for treatment. In addition, a soil vapor extraction (SVE) system was installed. This SVE system consisted of a vacuum pump connected to perforated 4-inch diameter PVC pipe placed horizontally in the recovery trenches approximately 2 feet above the horizontal groundwater/product recovery piping and GAC canisters for treatment of the extracted vapors. The groundwater/product recovery system was operated from March 25, 1993 until December 16, 1993. A total of 226,420 gallons of groundwater was treated and 62 gallons of product were recovered. The SVE system was operated from August 13, 1993 until December 16, 1993. The SVE system included the on-site regeneration of the GAC canisters. 185 gallons of SVE solvent were recovered from the GAC canisters by regeneration.

TABLE 2-1
Summary of Previous Investigations at OU-3/IRP Site 21

Date	Author	Authority	Report	# Samples/Media
1992	Zenone, Inc.	MCP	Final Report for Preliminary Remedial Investigation, Interim Measure Design, and Groundwater Recovery, March 1994	Soil gas survey: 119 locations 25 soil borings and wells installed 23 groundwater samples 59 soil samples
1995	Kestrel Drilling and Remediation, Inc.	CERCLA	Release Abatement Measure Plan, IRP Site 21, March 1995.	2 pilot extraction wells 6 vacuum monitoring points 12 groundwater samples
1995	Kestrel Drilling and Remediation, Inc.	CERCLA	Soil Gas Survey, Unit 21, July 1995	Soil gas survey: 35 locations
1995	EPA	CERCLA	XRF Screening Report of Hanscom AFB Site, Project #95373, August 1995	31 surface soil samples
1997	ECS	CERCLA	Remedial Investigation, IRP Site 21, September 1998/Finalized April 1999	Soil gas survey: 2 locations 68 Soil Borings, 22 completed as monitoring wells 50 soil samples 32 groundwater samples 3 surface water samples
1999	CH2M HILL	CERCLA	Supplemental Remedial Investigation, Finalized July 2000	7 soil borings, all completed as monitoring wells 7 subsurface soil samples 4 catch basin/outfall water samples 42 groundwater samples

During the summer of 1995, a CERCLA Removal Action was initiated. This included a pilot study followed by the installation of a SVE and groundwater recovery and treatment system. This Removal Action included 9 new dual-phase (groundwater/product and SVE) wells (RW-1 through RW-9) in Zones 2, 3, and 4 and the pre-existing recovery trenches in Zone 1. Operation of this system commenced September 27, 1995 and was terminated at the end of October 1998. Recovered groundwater and product were pumped to an oil-water separator and then through GAC canisters housed in a mobile treatment unit. Soil vapors were extracted by a vacuum pump and passed through GAC canisters housed in a second mobile treatment unit. Quarterly groundwater treatment system monitoring reports were prepared and submitted to the MADEP and USEPA. In 1997, recovery from the 3 trenches was stopped and the system augmented with four additional dual-phase wells (RW-10 through

RW-13). During the life of this contract an estimated 3.2 million gallons of groundwater was treated and 1,451 gallons of product was recovered. In addition, an estimated 1,679 gallons of vapor-phase solvent was recovered by the on-site regeneration of the SVE GAC canisters.

During the summer of 1999, a demonstration project commenced to evaluate the effectiveness of a VER system in LNAPL Pool A. VER is a dual-phase (liquids and vapors) recovery system utilizing a high vacuum (approximately 12 to 18 inches of mercury [Hg] vacuum) to remove product, groundwater, and soil vapor from a well. Installation of the system, which included 3 recovery wells in LNAPL Pool A, was completed in October 1999. Treatment components of the system include an electrical catalytic thermal oxidizer to treat vapors, an oil-water separator to recover product, and sand filter and GAC canisters to treat water. The system was placed in operation on 29 October 1999 but immediately was plagued by design, operational, and weather problems. As a result, the system has only been operated sporadically since its start-up with no discernible impact on LNAPL Pool A. The remedial actions conducted at IRP Site 21 are summarized in Table 2-2 below.

TABLE 2-2
Summary of Previous Remediation Activities at OU-3/IRP Site 21, Hanscom AFB

Date		Action	Results
1990-1991	MCP Interim Measure/DEP Case No. 3-3315	Passive Recovery System (1 recovery well) for 8 weeks in the vicinity of Building 1823. Contractor: GZA Remediation, Inc.	25 gallons of jet fuel recovered
1993	MCP Interim Measure/ DEP Case No. 3-3315	200 Linear Feet of Horizontal Recovery Trench. Operation of Soil Vapor Extraction (SVE) system for 4 months, and Groundwater Recovery/Treatment System for 8 months. Contractor: Zenone, Inc.	1,400 tons of petroleum contaminated soil removed 226,420 gallons of groundwater recovered/treated 62 gallons of petroleum product recovered 185 gallons of SVE solvent recovered
1995 thru Oct 1998	CERCLA Removal Action	9 to 13 Recovery Wells & Zenone's Recovery Trenches. Operation of Soil Vapor Extraction (SVE) and Groundwater Recovery/Treatment System Sep 95 thru Oct 98. Contractor: Kestrel Drilling and Remediation, Inc.	3,191,356 gallons of groundwater recovered/treated 1,451 gallons of petroleum product recovered 1,679 gallons of SVE solvent recovered
1999-2000	CERCLA Removal Action	3 Recovery Wells. Operation Vacuum Enhanced Recovery (VER) System Sep 99 thru Jul 00 Contractor: Arcadis Geraghty & Miller, Inc.	67,730 gallons of groundwater recovered/treated
2000	CERCLA Removal Action	Continued Operation of Vacuum Enhanced Recovery (VER) System Oct thru Dec 00 Contractor: IT Corp	231,408 gallons of groundwater recovered/treated

2.2.3 History of CERCLA Enforcement Activities

Hanscom AFB, including Hanscom Field, was listed on the NPL in May 1994. Of the 22 IRP sites with known or suspected contamination, 13 are closed-out with No Further Response Action Planned (NFRAP) and 2 are excluded from the purview of CERCLA by the petroleum exclusion clause and have been deferred to the state for regulation under the Massachusetts Superfund Law. The remaining 7 IRP sites have been designated as CERCLA regulated sites and fall under USEPA's lead regulatory jurisdiction. These CERCLA sites were grouped into four operable units. Operable Unit 3 consists of IRP Sites 6 and 21.

When Hanscom AFB was designated a NPL site in May 1994 it became regulated under CERCLA rather than the Massachusetts Contingency Plan (MCP). The Commonwealth of Massachusetts has determined that the site is "Adequately Regulated" and defers to the federal requirements. In 1994, a comprehensive program was initiated to continue the ongoing Hanscom AFB IRP while addressing the issues raised by the NPL designation. In 2000, Hanscom AFB and USEPA Region 1 conducted and concluded Federal Facility Agreement (FFA) negotiations. The FFA will establish goals and responsibilities between the USAF and USEPA and will set enforceable cleanup schedules. A couple remaining issues of national significance are being resolved at the Headquarters level at this time. The state has declined to participate in the FFA.

2.3 Community Participation

Throughout the site's history, community concern and involvement have been high. Hanscom AFB has kept the community and other interested parties apprised of site activities through informational meetings, fact sheets, press releases and public meetings. Below is a brief chronology of public outreach efforts.

- In the early 1980s, public briefings were periodically conducted during Hanscom Field Advisory Commission meetings regarding the Preliminary Assessment/Site Inspection phases of the CERCLA process.
- In the early 1980s, there was significant newspaper coverage of Hanscom AFB's Preliminary Assessment/Site Inspection/Remedial Action status.
- Technical Review Committee (TRC) meetings were conducted on June 1, 1993 and December 15, 1993.
- The TRC was expanded to become the Restoration Advisory Board (RAB) which has held meetings periodically since November 29, 1994. Updates on the Remedial Investigation, Feasibility Study, Proposed Plan and on-going Removal Action at IRP Site 21 have been routinely presented at RAB meetings since 1994 to date.
- On April 11, 1995, Hanscom AFB consultant, Kestrel Drilling and Remediation, made a presentation on a Proposed Removal Action at IRP Site 21 to the RAB.
- On May 5, 1995, Hanscom AFB published a notice and brief analysis of a Proposed Removal Action at Hanscom AFB in the local and Hanscom AFB newspapers and made the Engineering Evaluation/Cost Analysis (EE/CA) available to the public at the Bedford, Concord, Lexington and Lincoln Town Libraries and the Hanscom AFB Library.
- From May 8 to June 7, 1995, Hanscom AFB held a 30-day public comment period to accept public comment on the EE/CA.
- On June 15, 2001, copies of the Draft Proposed Plan were mailed to the RAB members.

- On July 10, 2001, copies of the Final Proposed Plan and information regarding the public comment period, public meeting, and public hearing were mailed to RAB members and the Chair of the Bedford Board of Health, and the Chief of the Bedford Public Works.
- On July 12, 2001, Hanscom AFB and USEPA published a notice and brief analysis of the Proposed Plan in the local and Hanscom AFB newspapers and made the plan and Final Feasibility Study available to the public at the Bedford Town Library and the Hanscom AFB Library. The notice included the time and date of the public meeting and hearing.
- From July 13 to August 13, 2001, Hanscom AFB and USEPA held a 30-day public comment period to accept public comment on the alternatives presented in the Feasibility Study and Proposed Plan.
- On August 1, 2001, Hanscom AFB and USEPA held an informational meeting at the Bedford Town Hall to discuss the results of the Remedial Investigation and the cleanup alternatives presented in the Feasibility Study and to present the Air Force's Proposed Plan to a broader community audience than those that had already been involved at the site. At this meeting, representatives from USEPA and Hanscom AFB responded to questions from the public.
- On August 1, 2001, Hanscom AFB and USEPA held a public hearing at the Bedford Town Hall to discuss the Proposed Plan and to accept any oral comments. A transcript of this meeting and the comments and responses to comments are included in the Responsiveness Summary (Appendix B).
- Throughout the CERCLA process the administrative record has been available for public review at the Hanscom AFB Environmental Flight Office, Hanscom AFB. This is the primary information repository for local residents and is kept up to date by Hanscom AFB.

2.4 Scope and Role of Response Action

As stated in Section 2.1.4 and as shown on Figure 2-1, the Hanscom AFB CERCLA sites have been grouped into 4 Operable Units. A summary of the CERCLA regulatory status for each of the Operable Units is as follows:

- A comprehensive Interim Record of Decision (IROD) for OU-1 was signed in February 2001 and the selected interim remedial action, consisting of the operation of the dynamic groundwater collection and treatment system at OU-1, has been implemented. OU-1 consists of DNAPL in source areas (IRP Sites 1,2 and 3) and a dissolved-phase VOC plume. The OU-1 IROD is comprehensive because operation of the dynamic groundwater collection and treatment system encompasses remedial efforts for IRP Sites 1,2, and 3, and also includes LTM, LUCs/ICs and 5-year reviews. In addition, the IROD was the decision document for choosing No Further Action for soils at IRP Sites 5 and 20.
- OU-2 is IRP Site 4, the former municipal landfill for Hanscom AFB. A Remedial Action Plan was finalized in 1988 and construction of the remedy (which included a low permeable cap, drainage measures and a compensatory wetland) was completed in the fall of 1988. Long-term monitoring of groundwater and surface water was conducted between December 1989 and September 1992. The preceding actions were conducted

prior to the listing of Hanscom Field/Hanscom AFB on the NPL with the MA DEP as the lead regulatory agency. In 1995 the Commonwealth deferred oversight to the EPA. In 1996 an ecological analysis was completed and supplemental monitoring of sediments, groundwater and surface water was completed in 1995 and 1996. In 1997 a Human Health Risk Assessment and an Ecological Risk Assessment were completed. Subsequently USEPA accepted the 1988 Remedial Action for OU-2 (IRP Site 4, Sanitary Landfill) as the final remedy and the first five-year review of the Hanscom Field/Hanscom AFB NPL Site was completed in 1997. This review concluded "based on the field inspection, and human health and ecological risk assessment, protectiveness of the landfill cap at Site 4 has been demonstrated."

- There are two (2) IRP sites associated with OU-3, IRP Sites 6 and 21. This ROD addresses OU-3/IRP Site 21. The IRP Site 6 Landfill ROD was signed in December 2000, the Remedial Design was completed in April 2001 and the Remedial Action was substantially complete on September 17, 2001. The remedy consists of wetlands sediment hotspot removal, off-site debris removal, permeable cap over landfilled areas, LTM, LUCs/ICs, and a groundwater compliance boundary between IRP Site 6 and the nearest receptor, the Shawsheen River.
- There are two (2) IRP sites associated with OU-4, IRP Site 7 (Former Industrial Waste Water Treatment System) and IRP Site 8 (Scott Circle Landfill). Both of these sites are closed-out. IRP Site 7 was closed-out in July 2000 following final regulatory concurrence with the Air Force's No Further Response Action Planned (NFRAP) Decision Document for OU-4/IRP Site 7. IRP Site 8 was closed-out in September 2001 following final regulatory concurrence with the Air Force's NFRAP Decision Document for OU-4/IRP Site 8 and supplemental monitoring of sediments, groundwater and surface water at the site that was completed in November 2000.

The OU-3/IRP Site 21 response action detailed in this ROD will provide protection of human health and the environment by reducing the toxicity, mobility and volume of contaminants by removing the source of groundwater contamination (i.e., LNAPL), and by treating the dissolved-phase groundwater contamination. The dissolved phase contamination consists of VOCs, BTEX, and chlorinated benzenes. The site risks associated with exposure to groundwater contamination will be also reduced through the implementation of LUCs/ICs.

Principal threat wastes are those source materials considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. The manner in which principal threats are addressed generally will determine whether the statutory preference for treatment as a principal element is satisfied. Wastes generally considered to be principal threats are liquid, mobile and/or highly-toxic source material. The principal threat wastes present at OU-3/IRP Site 21 that this ROD addresses are summarized in Table 2-3.

Low-level threat wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure. Wastes that generally are considered to be low-level threat wastes include non-mobile contaminated source material of low to moderate toxicity, surface soil containing chemicals of concern that are relatively immobile in air or ground water, low leachability contaminants or low toxicity source material. However, there are no low-level threat wastes present at OU-3/IRP Site 21.

TABLE 2-3
Principal and Low-level Threats
OU-3/IRP Site 21, Hanscom AFB

Principal Threats	Medium	Contaminant(s)	Action To Be Taken
Human contact and ingestion	Groundwater	Dissolved-phase contaminants (VOCs and fuel compounds)	Use of interceptor trenches and/or recovery wells to contain/treat groundwater, treatment with initial application of ORC® in trench excavations, implementation of LUCs/ICs, and long-term monitoring
Human contact	LNAPL and LNAPL saturated soil	LNAPL	LNAPL and petroleum saturated soil removal, implementation of LUCs/ICs, and long-term monitoring
Low-Level Threats	**Medium**	**Contaminant(s)**	**Action To Be Taken**
None at OU-3/Site 21	Not applicable	Not applicable	Not applicable

2.5 Site Characteristics

Section 1.0 of the OU-3/IRP Site 21 Feasibility Study contains an overview of the Remedial Investigation and Supplemental Remedial Investigation. The significant findings of the Remedial Investigation and Supplemental Remedial Investigation are summarized below.

2.5.1 Site Overview

2.5.1.1 Regional Climatology

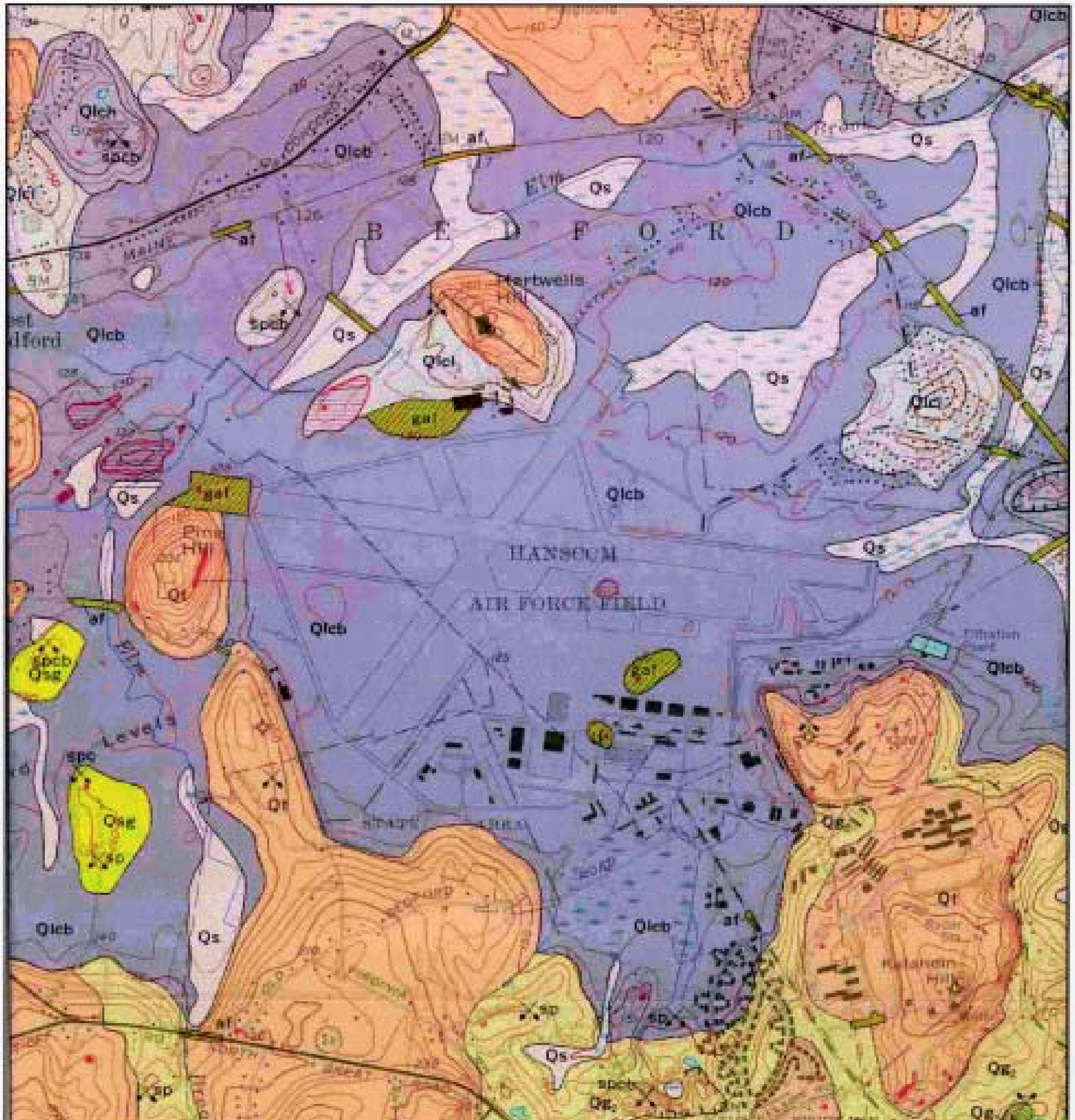
The climatic conditions at the site are generally characterized as being a continental climate somewhat influenced by the Atlantic Ocean to the east. Weather patterns vary considerably on a year-to-year and daily basis due to the prevailing northeasterly winds (JRB Associates, 1984). According to the JRB Report, average annual precipitation is 44 inches, average annual snowfall is 56.6 inches, maximum 24-hour precipitation is 8.7 inches, and maximum 24-hour snowfall is 16.5 inches (based on 87 years of record keeping). Evapotranspiration ranges between 22 and 28 inches per year.

2.5.1.2 Topography and Surficial Geology

The topography and surficial geology of the OU-3/IRP Site 21 area is illustrated in Figure 2-3. Topographically, the central part of the Hanscom AFB/Hanscom Field area is a low-lying basin surrounded by hills. The relatively flat runway portion of Hanscom Field lies in the ancient lake bed of glacial Lake Concord. The ground surface elevation on this former lake bed ranges from 120 to 130 feet above mean seal level (MSL). The hills to the south of the airfield area, and Pine Hill to the west, rise to more than 200 feet MSL. Hills north of the airfield area are more subdued, but still rise above 150 feet MSL.

2.5.1.3 Regional Geology

The bedrock unit underlying most of the Hanscom AFB/Hanscom Field area is known as the Andover Granite, which is part of the plutonic series of the Nashoba Block. The Andover Granite is characterized by a series of foliated and unfoliated, garnet-bearing,



0 1 Mile 2 Miles

N

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gaf	graded and filled	Qlcl	low stage lake deposits
Qg_2	sand, gravel, and silt	Qs	swamp deposits
Qlcb	lake bottom deposits	Qsg	sand and gravel
Qlch	high stage lake deposits	Qt	till

Source: U.S. Geological Survey Map GQ-331. Surficial Geology of the Concord Quadrangle. Carl Koteff, 1964.

Figure 2-3
TOPOGRAPHY AND SURFICIAL GEOLOGY
OU-3/ Site 21
Hanscom Air Force Base

CH2MHILL

Hanscom Site 21 FS/Figures/Figure 1_5.pdf muscovite-biotite granites and pegmatite (Hepburn and Munn, 1984). The northeast portion of the area is underlain by the Assabet Quartz Diorite and the Shawsheen Gneiss. The Assabet Quartz Diorite is part of the Nashoba Block plutonic series and the Shawsheen Gneiss is part of the metamorphosed stratified rock sequence of the Nashoba Block.

The Bloody Bluff fault zone is approximately one mile east of the airfield. This fault zone forms the southeasterly boundary of the Nashoba Block. Younger and less extensive north-northeast trending faults have been mapped to the north and south of the Hanscom AFB area. These faults likely extend beneath Hanscom AFB.

Erosional and depositional processes active during the Pleistocene glaciation modified the landscape in the region until the final retreat of glacial ice from the area approximately 13,000 years ago. As the ice retreated from the area, glacial meltwaters formed glacial Lake Concord between the ice front to the north and the hills south of the airfield. Glacial meltwaters transported and deposited sediments within the lake.

In the vicinity of the Hanscom AFB/Hanscom Field, glacial sediments consist mainly of glacial outwash materials (material deposited by glacial meltwaters), glacial lacustrine deposits formed in glacial Lake Concord, and glacial till deposits formed in contact with glacial ice. The lacustrine deposits are discontinuous since Lake Concord did not submerge the topographically elevated areas. These elevated areas are generally composed of glacial till sediments and bedrock.

Outwash sediments overlie much of the lacustrine deposits. These sediments consist of silts and fine to coarse sands. In addition to the naturally occurring deposits, extensive areas in the vicinity of the AFB and Hanscom Field have been filled and graded for construction purposes.

IRP Site 21 which is south of the Shawsheen River, is covered by fill material. In general, the fill material ranges from two feet to four feet in thickness. The fill material is underlain by glaciofluvial and glaciolacustrine (GFL) deposits, which typically become more coarse-grained towards the north. The GFL unit includes a discontinuous layer of varved silt with clay in the vicinity of borings CH-102, ECS-30L, and CH-105. According to ECS, the clay material was also observed while drilling ECS-28. Although the varved silt with clay material could potentially act as a confining layer, it appears that it is present in discontinuous layers that are unlikely to be isolating portions of the aquifer. The GFL unit is underlain by a diamicton till unit. The elevation of the upper surface of the diamicton unit decreases towards the Shawsheen River. The thickness of the diamicton unit at the site is unknown since bedrock was not encountered during drilling. However, based on information contained in the RI Report, the diamicton unit appears to be at least 20 feet thick along the southern flank of the site below the former above ground storage tank area. A more detailed discussion of the geologic units and the site stratigraphy is included in the ECS RI Report.

2.5.1.4 Hydrology

Former Glacial Lake Concord, and Hanscom AFB on its southern edge, drains to the Shawsheen River, which flows north-northeast from the site to join the Merrimack River approximately 15 miles downstream. The river starts just north of State Road 2A (North Great Road), which corresponds approximately to a drainage divide. It flows northward through the main housing and administrative area of Hanscom AFB, sometimes as an open

channel and sometimes through culverts. Prior to the construction of the air base, much of the ancient lake bed south of the present runways was swamp land. The Hanscom AFB/Hanscom Field area now has an extensive storm drain network, but there are still isolated wetland areas. After emerging from culverts north of Katahdin Hill, the Shawsheen River flows as an open stream eastward along the Hanscom AFB and Hanscom Field boundary, past IRP Site 21 and then flows out of the area to the east and north.
The US Geological Survey (USGS) has established a stream gauging station in the headwaters of the Shawsheen River in the vicinity of OU-3/IRP Site 21. Flow records for 1995 and 1996 indicate a minimum flow of about 1.4 cubic feet per second (cfs) at this gauge. This was taken as an estimate of the base flow of the stream at this point. It includes groundwater seepage into the storm drain system under the Hanscom AFB housing and administrative area. These drains are observed to flow even when there has been no rain for several weeks.

2.5.1.5 Hydrogeology

Groundwater flow occurs both in the fractured and weathered bedrock below the base and in the unconsolidated sediments above the bedrock. The bedrock is predominantly granite, but some zones of gneiss, schist, and diorite have been encountered. Most borings into the bedrock in this area have encountered numerous fractures, some filled with silt. No predominant direction of fracturing has been identified. Rock Quality Designations range from 10 to 100% with an average of 85%. The majority of the borings penetrated less than 50 feet into bedrock. It is not known how deep into the bedrock significant groundwater flow persists at the base. A review of bedrock production wells in the vicinity of Hanscom AFB revealed seven wells with depths of bedrock penetration ranging from 71 feet to 1004 feet.

The unconsolidated sediments from the top of bedrock to the ground surface can best be characterized by distinguishing between the low-lying areas of the glacial Lake Concord basin and the surrounding hills. In the ancient lake bed, the unconsolidated sediments are glacial and lacustrine deposits that form two transmissive zones separated by a semi-confining unit. The lower transmissive zone is in direct contact with the bedrock. It generally includes a sandy glacial till lying directly on the rock surface, and a coarser sand and gravel outwash. The thickness of this unit varies from 0 to 60 feet, pinching out at the bases of the hills. Above this lower aquifer, is a lacustrine silt and clay layer of relatively low hydraulic conductivity. This semi-confining unit is not continuous, as it pinches out at the hills and has been eroded away under Elm Brook just north of Hartwells Hill. Its thickness varies from 0 to more than 50 feet. The upper transmissive zone is a lacustrine sand unit. In some areas this sand is well sorted, and in others it includes grain sizes ranging from very fine sand and silt to fine gravel. The thickness of the lacustrine sand varies from 0 to 30 feet.

The hills are composed of a raised bedrock surface covered with glacial till. In some areas, such as Hartwells Hill, two types of till, sandy till and clayey till, have been identified. The clayey till generally lies directly on the bedrock surface. It is quite dense, and has a lower hydraulic conductivity than the sandy till. Its areal extent is also more limited. The sandy till consists of unsorted sand and silt with varying amounts of clay and gravel. It generally extends to the ground surface in the hilly areas.

2.5.1.6 OU-3/IRP Site 21 Groundwater Migration

Groundwater migration at OU-3/IRP Site 21 was evaluated as part of both the ECS RI and the 1999 Supplemental RI field activities. Figures 2-4 and 2-5 illustrate groundwater elevation and flow maps from the 1999 Supplemental RI for the two hydrostratigraphic units; the GFL and diamicton (till) units. Based on the potentiometric surfaces in wells screened within the GFL unit, groundwater migration below Zones 1 and 2 is generally from east to west. Groundwater flow below the northern portion of IRP Site 21 (below Zones 3, 4, and 5 and the former railroad right-of-way) is generally towards the west-northwest and trends toward the north below the northeastern portion of the site. The direction of groundwater flow, as well as the flow gradients, from the Supplemental RI are similar to those reported by ECS in the RI.

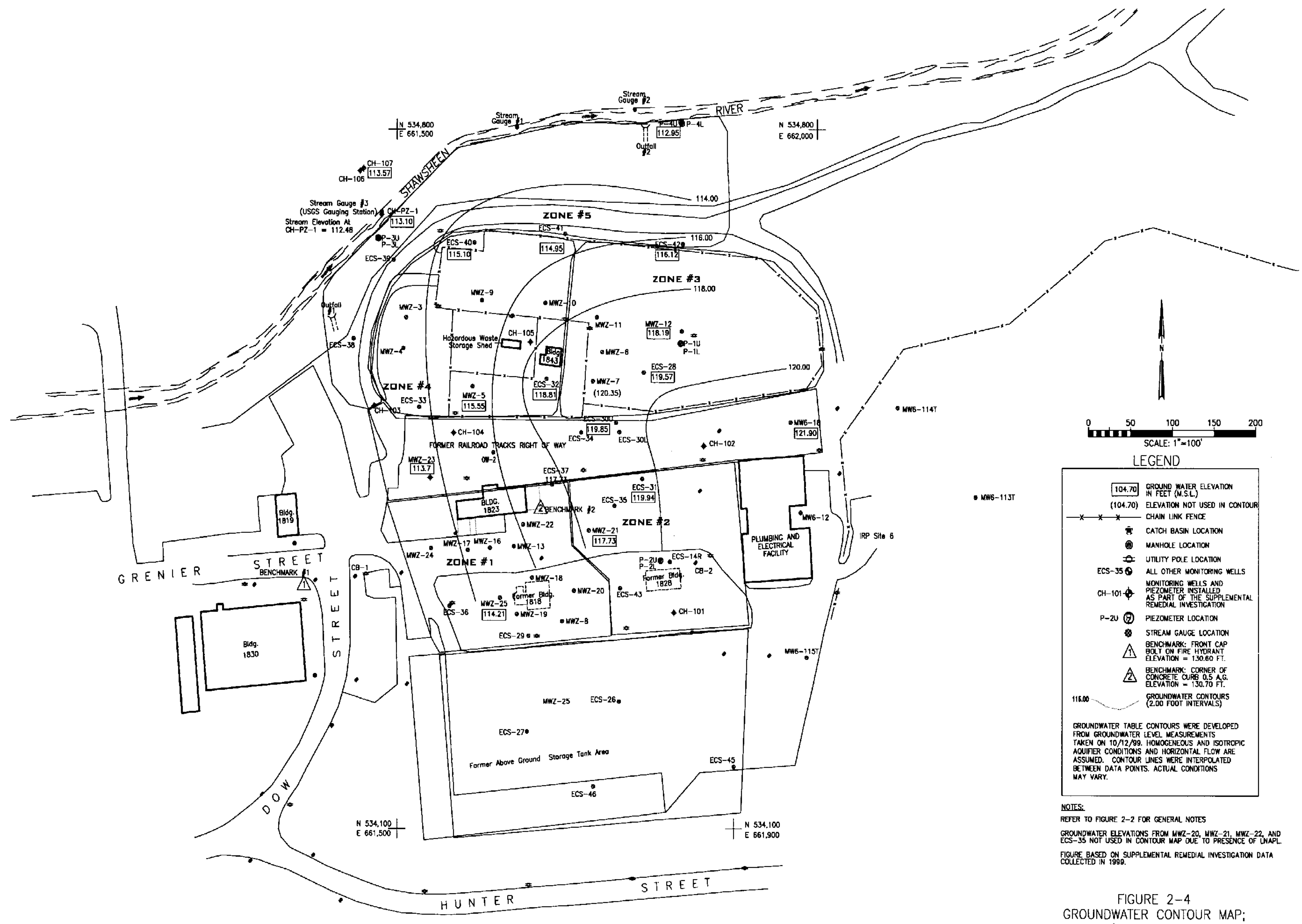
Based on the observation of the potentiometric surfaces in wells screened within the diamicton unit, groundwater flow in the till layer at IRP Site 21 is towards the west-northwest. The piezometric surface calculated at CH-106, which is located northwest of the Shawsheen River, is at a greater elevation than the piezometric surface calculated for the wells located south of the Shawsheen River, ECS-39, P-1L, and P-1U. This suggests that flow in the diamicton unit on the north side of the Shawsheen River is flowing towards the river (i.e., to the south). Based on the measurements collected at P-3L, P-3U, CH-PZ-1, and the stream, the Shawsheen River is an influent stream, where groundwater from the diamicton unit is discharging to the Shawsheen River. An analysis of the groundwater elevation data at the well couplets ECS-30U/ECS-30L, located on the southern side of the Shawsheen River, and CH-106/CH-107, located on the northern side of the river, indicates that a downward vertical gradient exists on both sides of the river. Both the Supplemental RI groundwater flow pattern in the diamicton unit and the observed vertical gradients are similar to those reported by ECS in the RI Report.

2.5.2 Type of Contamination and Affected Media

Numerous investigations have been conducted to determine what contamination exists at OU-3/IRP Site 21, exactly where the contamination is located, and whether or how the contamination is moving. Concentrations of chlorinated VOCs, chlorinated benzenes, benzene, toluene, ethylbenzene, and xylenes (BTEX), polycyclic aromatic hydrocarbons (PAHs), and total petroleum hydrocarbons (TPH) have been detected in various media at the site. In addition, three separate areas of petroleum products floating on the water table have been identified at the site. These areas are technically referred to as light non-aqueous phase liquid (LNAPL) pools and are discussed below in Section 2.5.2.1, *Light Non-Aqueous Phase Liquid (LNAPL)*.

2.5.2.1 Light Non-Aqueous Phase Liquid (LNAPL)

LNAPL has been observed in wells located in Zones 1, 2, and 4 at the site during previous investigations. Product was consistently detected in eight wells during monthly water level measurements collected between September 1995 and July 1996. LNAPL thickness ranged from 0.04 feet to 5.32 feet in September 1995, and decreased to between 0.01 feet and 2.52 feet by July 1996. LNAPL thickness ranging from 0.04 feet to 0.54 feet were observed in 11 wells during the RI gauging round by ESC in October, and December, 1997. During the Supplemental RI, CH2M HILL detected LNAPL in ten monitoring wells located in Zones 1, 2, and 4 at the site. LNAPL has never been detected in the monitoring wells in Zone 3, Zone 5, the former railroad right-of-way and the former AST area. LNAPL thickness ranged from 0.01 feet to 2.08 feet during the Supplemental RI in October 1999. The greatest LNAPL thickness were observed in Zone 4 monitoring wells. Figure 2-6 illustrates the estimated areal extent of LNAPL below the site based on the Supplemental RI data. Three LNAPL



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104.70 (boxed)	GROUND WATER ELEVATION IN FEET (M.S.L.)
(104.70)	ELEVATION NOT USED IN CONTOUR
—x—x—	CHAIN LINK FENCE
	CATCH BASIN LOCATION
	MANHOLE LOCATION
	UTILITY POLE LOCATION
ECS-35	ALL OTHER MONITORING WELLS
CH-101	MONITORING WELLS AND PIEZOMETER INSTALLED AS PART OF THE SUPPLEMENTAL REMEDIAL INVESTIGATION
P-2U	PIEZOMETER LOCATION
	STREAM GAUGE LOCATION
1	BENCHMARK: FRONT CAP BOLT ON FIRE HYDRANT ELEVATION = 130.60 FT.
2	BENCHMARK: CORNER OF CONCRETE CURB 0.5 A.G. ELEVATION = 130.70 FT.
116.00	GROUNDWATER CONTOURS (2.00 FOOT INTERVALS)

GROUNDWATER TABLE CONTOURS WERE DEVELOPED FROM GROUNDWATER LEVEL MEASUREMENTS TAKEN ON 10/12/99. HOMOGENEOUS AND ISOTROPIC AQUIFIER CONDITIONS AND HORIZONTAL FLOW ARE ASSUMED. CONTOUR LINES WERE INTERPOLATED BETWEEN DATA POINTS. ACTUAL CONDITIONS MAY VARY.

NOTES:

REFER TO FIGURE 2-2 FOR GENERAL NOTES

GROUNDWATER ELEVATIONS FROM MWZ-20, MWZ-21, MWZ-22, AND ECS-35 NOT USED IN CONTOUR MAP DUE TO PRESENCE OF LNAPL.

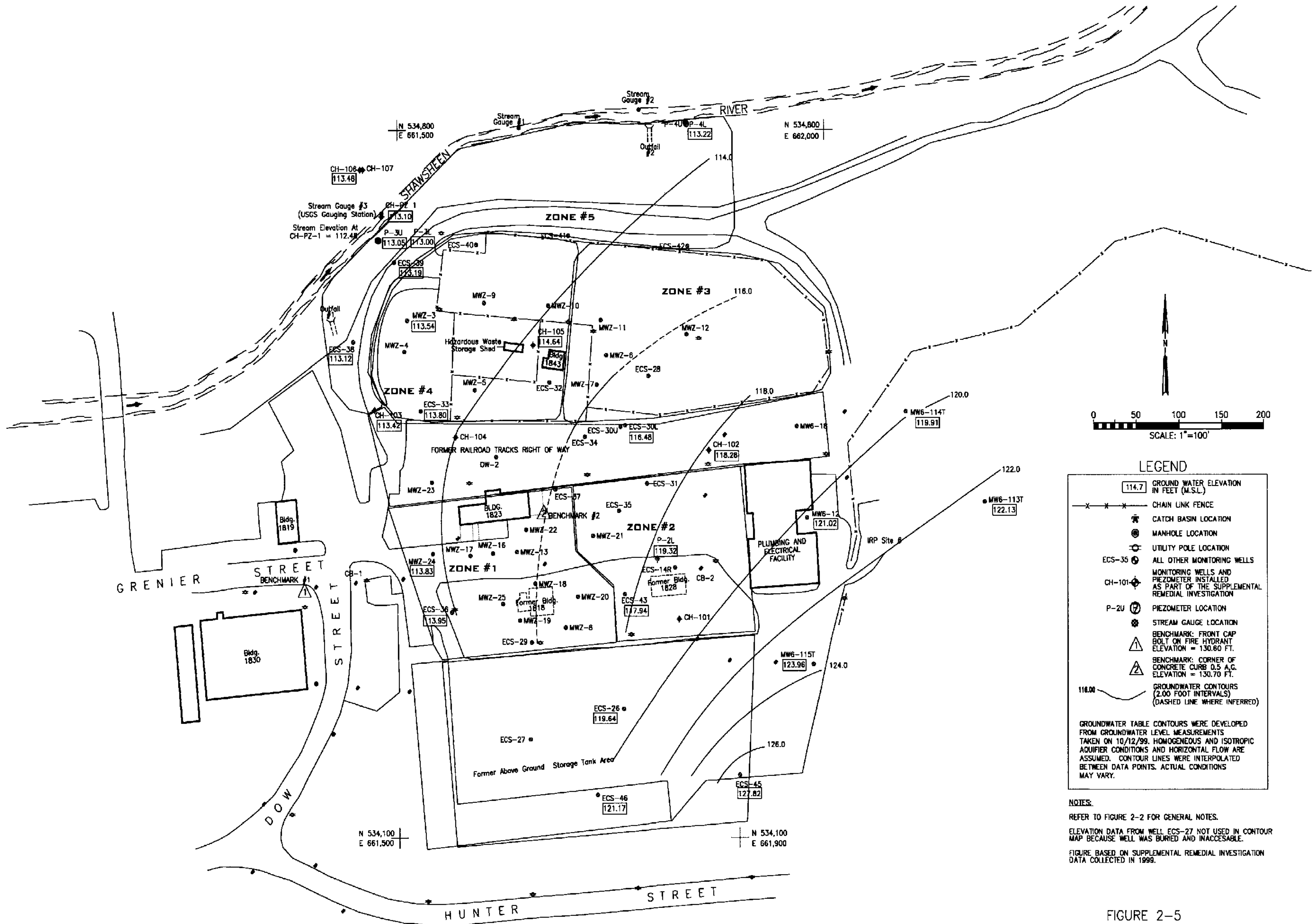
FIGURE BASED ON SUPPLEMENTAL REMEDIAL INVESTIGATION DATA COLLECTED IN 1999.

FIGURE 2-4
GROUNDWATER CONTOUR MAP;
GLACIOFLUVIAL/GLACIOLACUSTRINE DEPOSITS

IRP SITE 21
HANSCOM AIR FORCE BASE
BEDFORD, MASSACHUSETTS

CH2MHILL

07-19-01 CAD/160423/FIGURE2-4.DWG



NOTES:

REFER TO FIGURE 2-2 FOR GENERAL NOTES.

ELEVATION DATA FROM WELL ECS-27 NOT USED IN CONTOUR MAP BECAUSE WELL WAS BURIED AND INACCESABLE.

FIGURE BASED ON SUPPLEMENTAL REMEDIAL INVESTIGATION DATA COLLECTED IN 1999.

FIGURE 2-5
GROUNDWATER CONTOUR MAP; DIAMICTON DEPOSITS

IRP SITE 21
HANSCOM AIR FORCE BASE
BEDFORD, MASSACHUSETTS

07-19-01 CAD/160423/FIGURE2-5.DWG

CH2MHILL

pools are apparent, one located in the vicinity of monitoring wells MW-9 and MW-10 in Zone 4 which is referred to as "Pool A", another located in the vicinity of monitoring well ECS-33 in Zone 4 which is referred to as "LNAPL Pool B", and one covering areas in both Zone 1 and 2 which is referred to as "LNAPL Pool C". LNAPL samples collected from four wells during the ECS RI identified the LNAPL as aviation fuel, specifically JP-4 jet fuel.

Given the locations of the LNAPL pools and the distribution of the contaminants detected in groundwater at the site, it was concluded that the LNAPL is acting as a source for the petroleum related contaminants found in the groundwater. Fortunately, it appears that the LNAPL pools are not migrating due to the fine grained soils at the site which have high adsorptive qualities, and the natural biodegradation of the contaminants.

2.5.2.2 Groundwater Contamination

Dissolved-phase chlorinated VOCs (solvents) including tetracholoroethylene (PCE), trichloroethylene (TCE), vinyl chloride, and cis-dichloroethylene (cis-DCE) have been detected in groundwater co-mingled with the petroleum related contaminants (associated with the LNAPL) throughout OU-3/IRP Site 21. Contaminants detected above MCLs in groundwater during the 1997 sampling and analysis for the RI are presented in Table 2-4 by sample location, i.e., beneath LNAPL Pools A, B, or C or from the dissolved-phase plume. Groundwater contaminant concentrations detected during the RI are also presented in Figures 2-6, 2-7, and 2-8.

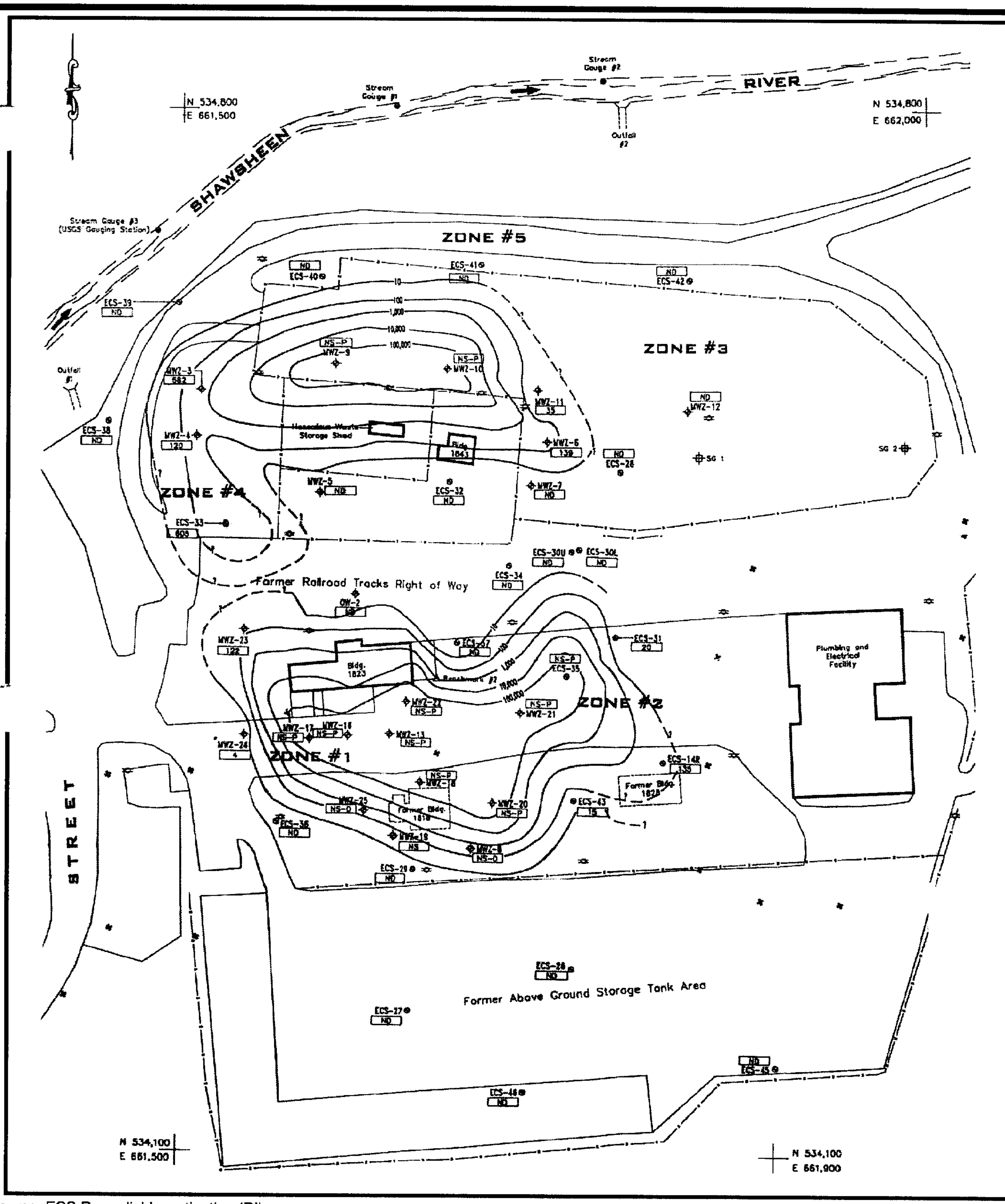
Contaminants detected above MCLs in groundwater during the 1999 sampling and analysis for the Supplemental RI are presented in Table 2-4 by sample location, i.e., beneath LNAPL Pools A, B or C or from the dissolved-phase plume. Groundwater contaminant concentrations detected during the Supplemental RI are also presented in Figures 2-9 and 2-10.

Given the location of the wells containing LNAPL and the distribution of the dissolved petroleum-related compounds (including benzene, toluene, naphthalene, and TPH), it appears that the LNAPL Pools are acting as sources of the dissolved-phase petroleum contamination. The chlorinated benzenes (including 1,4-Dichlorobenzene, 1,2-Dichlorobenzene, and 1,2,4-Trichlorobenzene) are probably also related to the LNAPL and are by-products of the fuel reforming process due to the fuel reforming catalysts with chlorine or chlorine derivatives in them. The detection of chlorinated aliphatics (including TCE, cis-DCE, and vinyl chloride) is probably the result of spills or releases associated with the historic use and storage of cleaning solvents at the site.

Based on groundwater monitoring data to date, the groundwater contamination does not appear to be migrating and has not adversely impacted the Shawsheen River. Similar to the LNAPL Pools, the stable nature of the dissolved-phase contamination is the result of the fine grained soils at the site and the natural biodegradation of the contaminants. In addition, the vertical migration of the dissolved-phase contamination is confined by a layer of diamicton till that underlies the sand and gravel water table aquifer.

2.5.2.3 Subsurface and Surface Soil

Soil contamination detected in the vadose zone centers around the locations of former fuel loading and unloading areas, especially along a former railroad spur line in Zones 3 and 4 and historical truck fuel facilities in Zone 2. Additional areas were detected in Zone 1 in a former truck loading rack area, an abandoned drywell, and underground fuel lines near the former ASTs.



Source: ECS Remedial Investigation (RI), IRP Site 21, Hanscom AFB, Bedford, MA

Note: Figure based on RI data collected in ~~7.

Legend

ECS-31 Well Identification
35 Total BTEX
ND = No Concentrations Detected Above PDL (Project Detection Limit) for BTEX & MTBE.
NS-P = Not Sampled, Product Present
NS-D = Not Sampled, Well Dry
35 Total BTEX Concentrations in (ug/L)
—10— Isoconcentration Contour Total BTEX in ppb (ug/L) (Dashed where inferred)

Scale

FIGURE 2-6
Total BTEX Isoconcentration Map, During the RI

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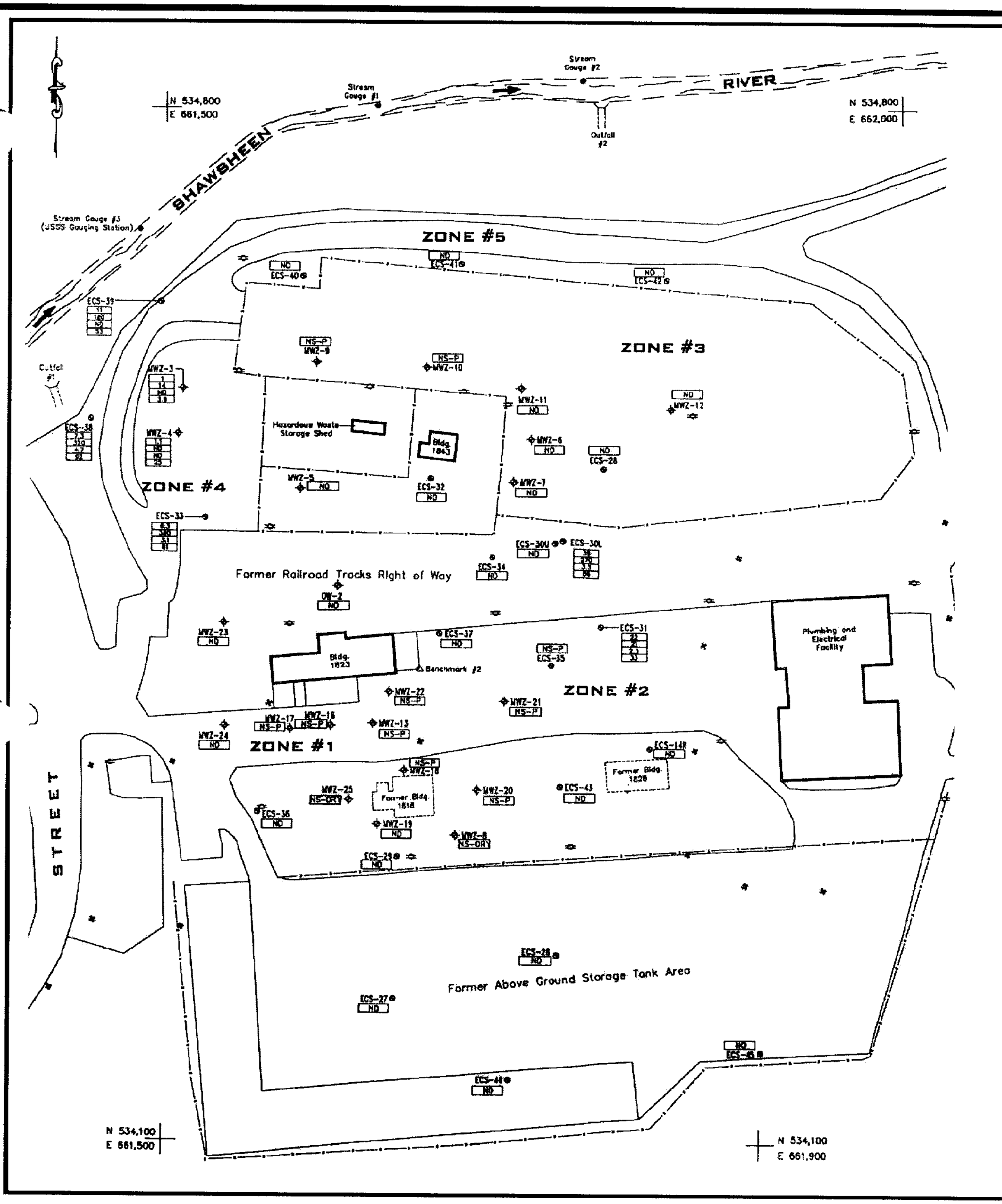

Source: ECS Remedial Investigation (RI), IRP Site 21, Hanscom AFB, Bedford, MA

Note: Figure based on RI data collected in 1997.

Legend

ECS-31 Well Identification

Chlorobenzene, 1,2-DCB, 1,3-DCB, 1,4-DCB

DCB = Dichlorobenzene

ND = No Concentration Detected Above MDL (Method Detection Limit)

Concentrations in (ug/L) Based on samples collected in October 1997.

NS-P = Not sampled Product in well.

NS-Dry = Not sampled Well Dry

FIGURE 2-7
Concentrations of Chlorinated Benzenes in Groundwater

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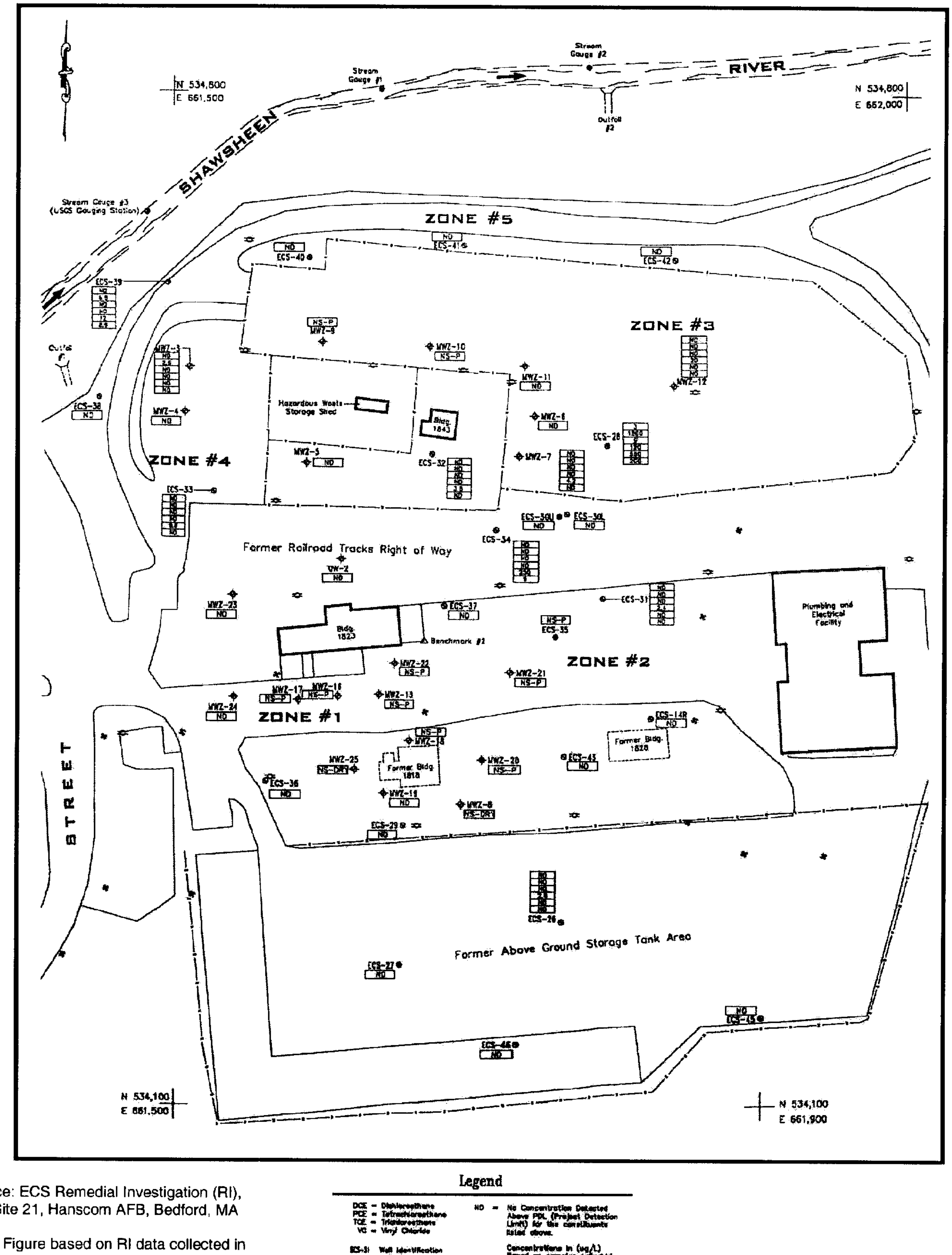

Source: ECS Remedial Investigation (RI), IRP Site 21, Hanscom AFB, Bedford, MA

Note: Figure based on RI data collected in 1997.

FIGURE 2-8
Concentrations of Chlorinated Aliphatics in Groundwater

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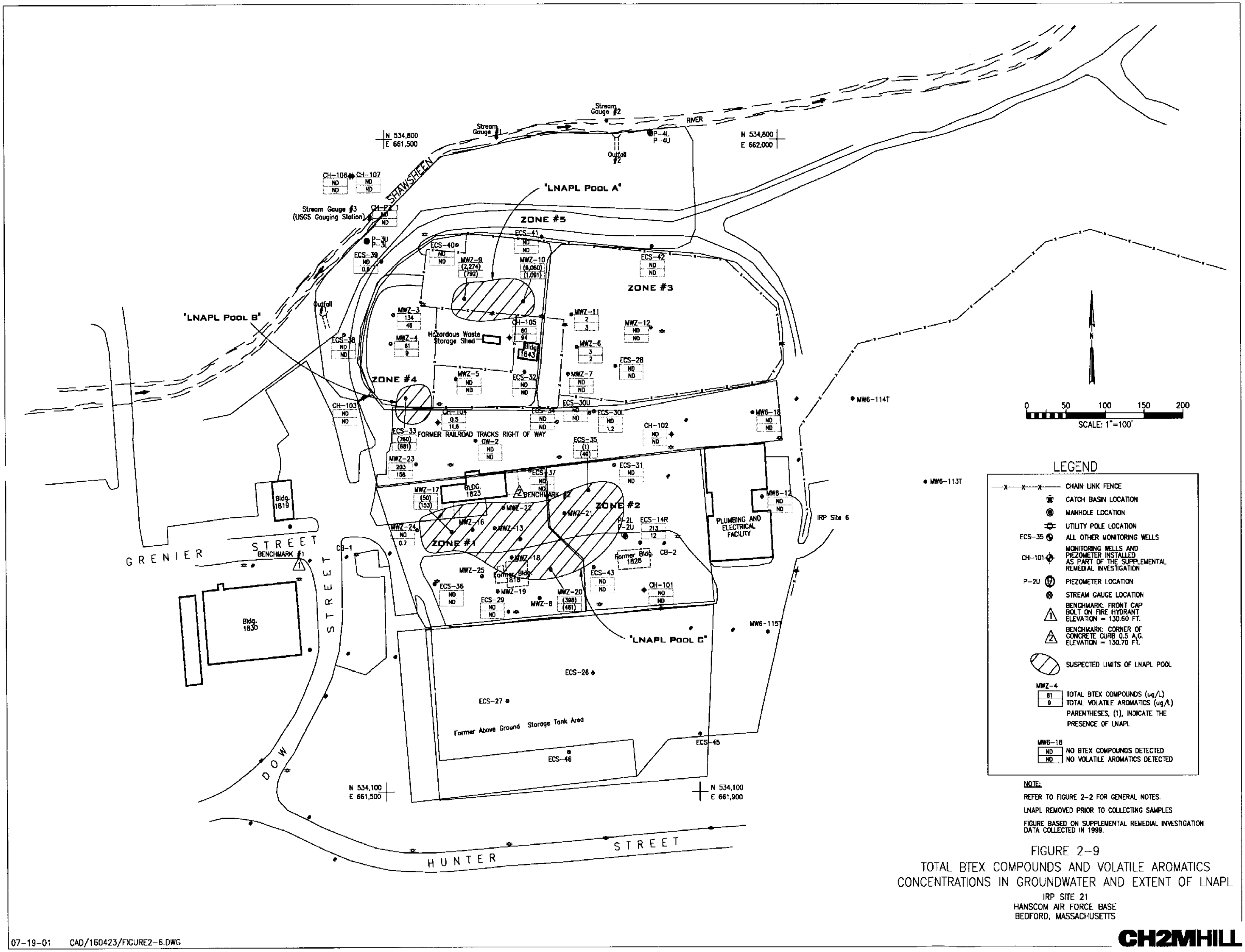
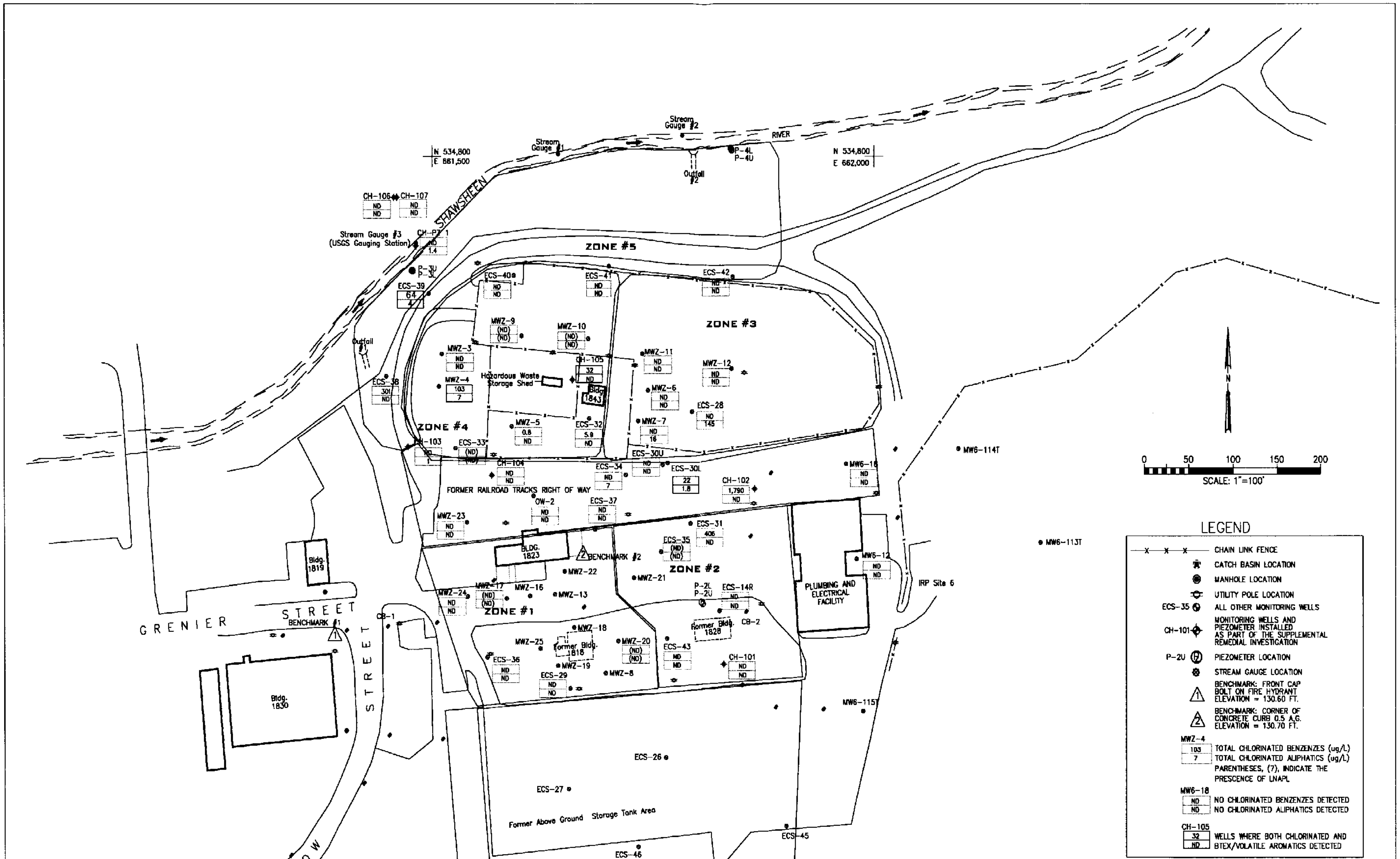


FIGURE 2-9
TOTAL BTEX COMPOUNDS AND VOLATILE AROMATICS CONCENTRATIONS IN GROUNDWATER AND EXTENT OF LNAPL
IRP SITE 21
HANSCOM AIR FORCE BASE
BEDFORD, MASSACHUSETTS



NOTE:

REFER TO FIGURE 2-2 FOR GENERAL NOTES.

LNAPL REMOVED PRIOR TO COLLECTING SAMPLES

FIGURE BASED ON SUPPLEMENTAL REMEDIAL INVESTIGATION DATA COLLECTED IN 1999.

FIGURE 2-10
TOTAL CHLORINATED BENZENES AND CHLORINATED ALIPHATICS CONCENTRATIONS IN GROUNDWATER

IRP SITE 21
HANSCOM AIR FORCE BASE
BEDFORD, MASSACHUSETTS

07-19-01 CAD/160423/FIGURE2-7.DWG

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TABLE 2-4
Contaminants of Concern in Groundwater – OU-3/IRP Site 21, Hanscom AFB, MA

Contaminant (exceeding MCL)	Maximum Concentration During SRI, 1999		Maximum Concentration During RI, 1997		MCL (Drinking Water Standard)
	Sample ID/Location	Max Conc.	Sample ID/Location	Max Conc.	
Source Area (LNAPL Pool A)					
Benzene	MW-10	150 µg/L	NA	NA	5 µg/L
Toluene	MW-10	1800 µg/L	NA	NA	1,000 µg/L
Naphthalene	MW-10	170 µg/L	NA	NA	20 µg/L[1]
Source Area (LNAPL Pool B)					
Naphthalene	ECS-33	73 µg/L	ECS-33	20 µg/L	20 µg/L[1]
2-Methylnaphthalene	NA	NA	ECS-33	24 µg/L	10 µg/L[1]
1,4-Dichlorobenzene	NA	NA	ECS-33	81 µg/L	75 µg/L
Trichloroethylene	NA	MA	ECS-33	8.8 µg/L	5 µg/L
Source Area (LNAPL Pool C)					
Naphthalene	MWZ-20	120 µg/L	NA	NA	20 µg/L[1]
Groundwater Plume					
1,4-Dichlorobenzene	CH-102	390 µg/L	ECS-38	92 µg/L	75 µg/L
1,2-Dichlorobenzene	CH-102	1400 µg/L	NA	NA	600 µg/L
1,2,4-Trichlorobenzene	ECS-31	84 µg/L	NA	NA	70 µg/L
vinyl chloride	ECS-28	37 µg/L	ECS-28	200 µg/L	2 µg/L
cis-1,2-Dichloroethene	ECS-28	100 µg/L	ECS-28	1,800 µg/L	70 µg/L
Tetrachloroethene	NA	NA	ECS-28	120 µg/L	5 µg/L
Trichloroethylene	MWZ-7	6 µg/L	ECS-28	550 µg/L	5 µg/L
Naphthalene	MWZ-23	33 µg/L	NA	NA	20 µg/L[1]
Benzene	ECS-14R	73 µg/L	MWZ-3	30 µg/L	5 µg/L
TPH	CH-102	2,900 µg/L	NA	NA	200 µg/L[1]

Notes:
[1] MCP Method 1 GW-1 standard used because no MCL exists.
During both the RI and SRI sampling events groundwater samples were not collected from wells where floating product was observed.
NA – not detected above MCL in that area (e.g., Source Area-LNAPL Pool C) during that sampling round.

Contaminants historically detected in soil at the site include: dichlorobenzenes including 1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene; chlorinated aliphatics including cis-1,2-dichloroethene, trans-1,2-dichloroethene and tetrachloroethene; BTEX compounds, PAHs including fluoranthene, 2-methylnaphthalene, phenanthrene, and pyrene; and TPH identified as aviation fuel, motor oil, and unidentified petroleum products.

Although these contaminants were detected in subsurface soil at the site, screening of all the soil data collected previous to and during the RI indicated concentrations did not exceed MCP Method 1 S-2/GW-3 standards. The RI and the Supplemental RI soil data were also screened against the EPA Region IX Industrial Soil Preliminary Remediation Goals (PRGs) during the Risk Assessment and only two compounds, benzene and 1,4-dichlorobenzene, exceeded the PRGs. The results of the risk assessment concluded that soils did not pose an unacceptable risk.

2.5.2.4 Shawsheen River Surface Water and Sediment

Shawsheen River surface water and sediment samples were collected in 1996 and again as part of the RI in 1997. The 1999 Supplemental RI also collected samples from Hanscom AFB's stormwater drainage system which flows into the Shawsheen River near the site. These sample results, and the results of sampling the groundwater from wells between the site and the river, indicate that the site's contaminants are not migrating into the river, either through groundwater discharge or through infiltration into the stormwater drainage system. However, the 1996 sampling of the river and the sediments in conjunction with the Supplemental RI for OU-3/IRP Site 6 did find some non site-related concentrations of PAHs in the sediments and metals in the surface water above applicable standards. Because the Shawsheen River upgradient of the site receives surface water runoff from a large portion of both Hanscom Field and Hanscom AFB, IRP Site 21 is likely a minor (if any) source of the PAHs and metals detected.

Since the storm water related compounds detected in samples collected from the Shawsheen River are from non-point sources such as runoff from roads and runways and, not from groundwater contaminants migrating from IRP Site 21, actions to address the Clean Water Act are outside the purview of CERCLA and this ROD. However, the headwaters of the Shawsheen River which includes Hanscom AFB and Hanscom Field are the subject of intensive study through the Massachusetts Watershed Initiative established to ensure Clean Water Act compliance. This section of the Shawsheen has been listed as "impaired" by the state and MA DEP has established a Shawsheen River Watershed Team to implement the Watershed Initiative. In fiscal year 1999 Hanscom AFB contracted the Merrimack River Watershed Council, Inc. to perform a Total Maximum Daily Loads (TMDL) study and currently Hanscom AFB's Stormwater Pollution Prevention Plan is being updated by the Merrimack River Watershed Council, Inc., to serve as the base Implementation Plan to address "habitat alterations" impairment in Segment MA 83-08 of the Shawheen River. The overall goal is to establish best management practices for the Hanscom AFB specific stormwater discharge conditions resulting in improved water quality and the removal of the "Hanscom" segment of the Shawsheen River from the state's list of impaired water bodies.

2.5.3 The Conceptual Site Model

The conceptual site model (CSM) is a three-dimensional "picture" of site conditions that illustrates contaminant sources, release mechanisms, exposure pathways/migration routes, and potential human and ecological receptors. The CSM documents current and potential future site conditions and shows what is known about human and environmental exposure from contaminant release and migration to potential receptors. The risk assessment and response actions for the contaminants at OU-3/IRP Site 21 are based on the CSM. Figures 2-8 and 2-9 present the CSMs for the OU-3/IRP Site 21 human and ecological risk assessment.

2.5.3.1 Site Overview

OU-3/IRP Site 21 is an area with groundwater contamination and three LNAPL pools which act as contaminant source areas for the groundwater. Dissolved-phase chlorinated aliphatics (solvents) are co-mingled in groundwater with the petroleum related contaminants dissolving from the LNAPL. Fortunately, it appears that the LNAPL pools and the groundwater contamination are not migrating and have not adversely impacted the Shawsheen River which is adjacent to the northern edge of the site. The stable nature of the product and dissolved-phase contamination is the result of the fine grained soils at the site which have high adsorptive qualities, and the natural biodegradation of the contaminants. In addition, the vertical migration of the dissolved-phase contamination is confined by a layer of glacial till that underlies the sand and gravel water table aquifer.

2.5.3.2 Exposure Pathways

Access to OU-3/IRP Site 21 is not restricted and there are workers present at the site, however, the contaminated media (LNAPL floating on the groundwater) is below the ground surface and is not accessible to current receptors. There is the possibility of future construction worker exposure, assuming invasive activities would result in contact with the subsurface LNAPL and groundwater. Groundwater is not used as a water supply at OU-3/IRP Site 21, or at the rest of Hanscom AFB, and is not expected to be used as a water supply in the near future. However, the risk assessment evaluated exposure to on-site groundwater by future residents as a hypothetical situation. A summary of the exposure pathways considered in the human health risk assessment are included in Table 2-5.

TABLE 2-5
Exposure Pathway Evaluation
Human Health Risk Assessment, OU-3/IRP Site 21, Hanscom AFB

Potentially Contaminated Medium	Potential Routes of Exposure	Potential Receptors	Pathway Complete?
Surface Soil	Incidental ingestion, dermal absorption, inhalation of fugitive dust and volatiles	Current Site Worker	No - no surface contamination, site paved and surface contamination has been removed
		Future Site Worker	No - no surface contamination
		Future Construction Worker	No - no surface contamination
Subsurface Soil	Incidental ingestion, dermal absorption, inhalation of fugitive dust and volatiles	Future Construction Worker	Yes
Groundwater (on-site)	Ingestion	Current and Future Site Worker	No – groundwater not used on site and not expected to be used in future
	Dermal absorption, inhalation of volatiles	Future Construction Worker	Yes
	Ingestion, inhalation of volatiles, dermal absorption	Current and Future Resident	No – future residential use of site unlikely (based on Hanscom AFB plan)[1].
Groundwater (off-site)	Ingestion, inhalation of volatiles, dermal absorption	Future Resident	Yes – potential future residential use of groundwater downgradient of site.

[1]Hypotheical future residential use of groundwater at Site 21 was evaluated as a conservative measure

2.6 Current and Potential Future Site and Resource Uses

The site is on an active Air Force Installation and is classified in the Hanscom Air Force Base General Plan (master plan) as either "Industrial" or "Outdoor Recreational" in both the Current Land and Future Land Use Plans. The General Plan also shows the site with "Environmental Constraints" (because of IRP Site status and proximity to Shawsheen River) and with "Operational Constraints" (due to proximity to Hanscom Field). Through these measures the use of the site is well controlled and managed.

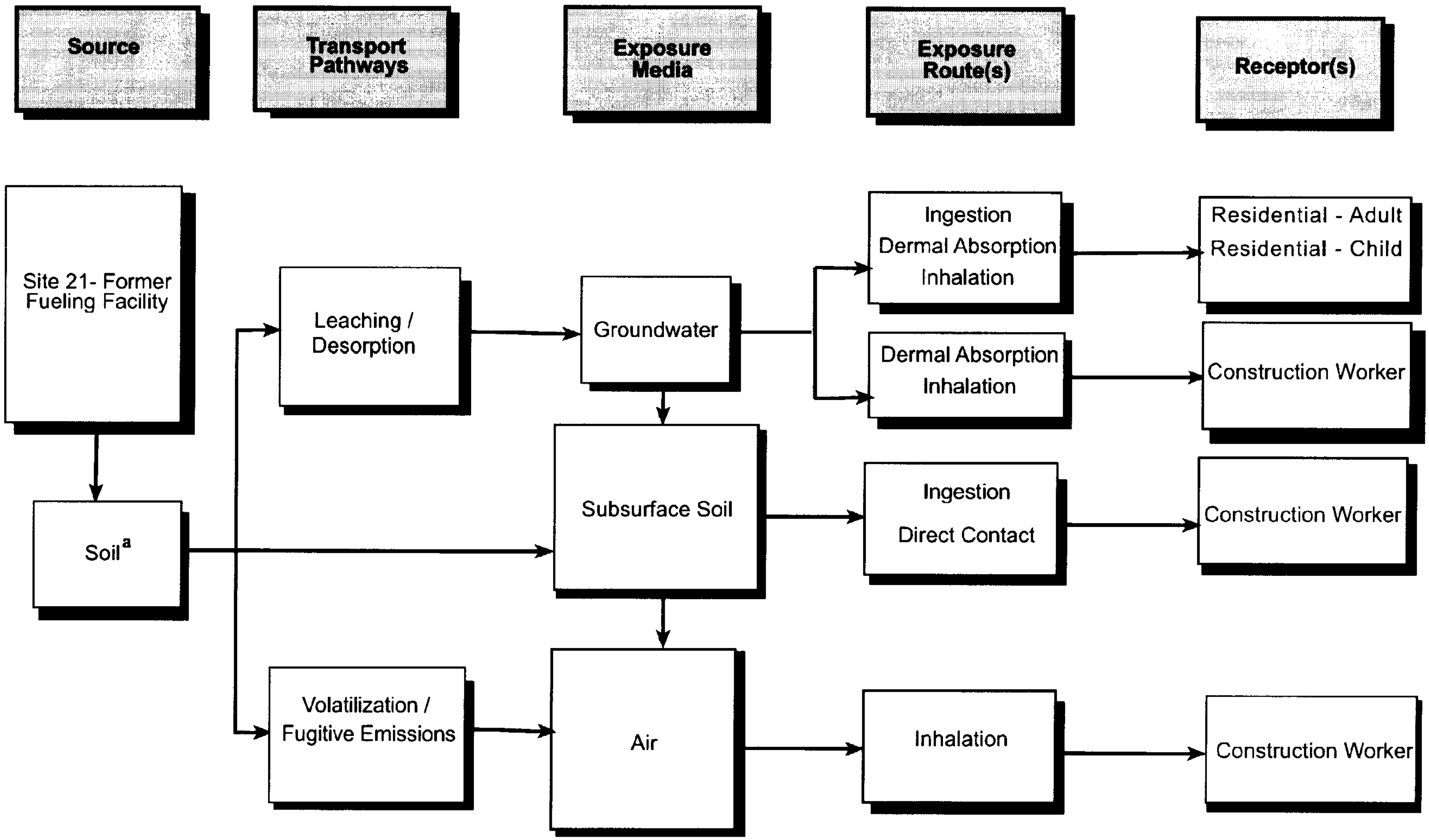

Figure 2-11
Conceptual Site Model
Potential Human Exposure
OU3/ IRP Site 21
Hanscom AFB, MA

Note:
a: No CPCs for surface soil, therfore no exposure to surface soil

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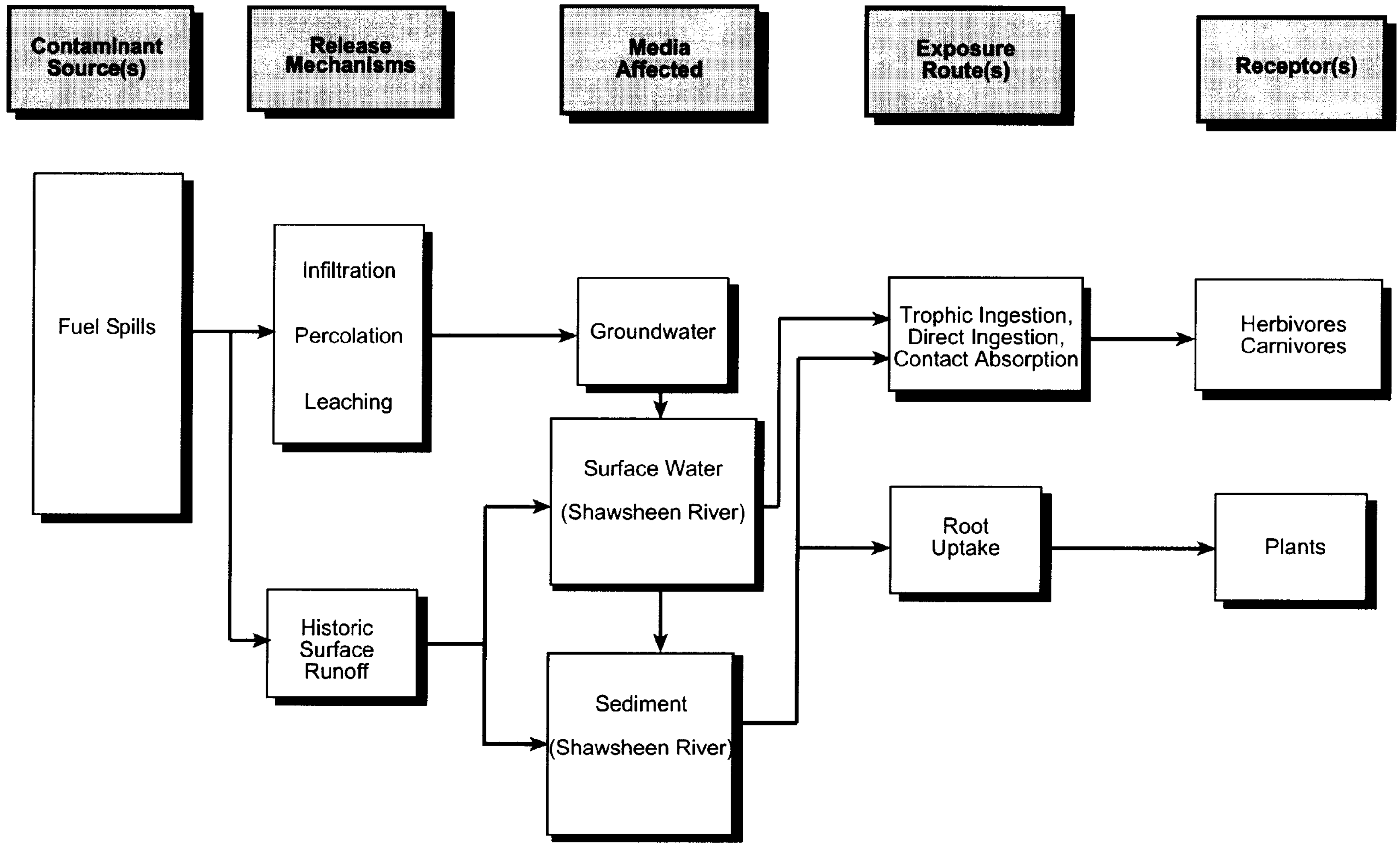

Figure 2-12
Conceptual Site Model
Potential Ecological Exposure
OU3/ IRP Site 21
Hanscom AFB, MA

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Most of the northern half of the site is as a controlled/fenced parking area for privately owned recreational vehicles and as a controlled/fenced general purpose storage area for bulky items that can be stored in the open. The remainder of the northern half is used as a staging area for contractors working on the base. The southern half of the site includes Building 1823 which is currently used as the base entomology facility; the former AST area which is currently used by the Base Roads and Grounds Maintenance Organization for parking equipment, materials storage, wood/brush chipping, and composting; and the access road to Building 1833 (base plumbing and fuels section), Building 1834 (family housing maintenance) and associated vehicle parking areas. The Shawsheen River bounds the site to the north. There are currently no plans to change the existing use of OU-3/Site 21 in the future.

Groundwater beneath and directly downgradient of OU-3/IRP Site 21 is not currently used as a drinking water supply, and it is not expected to be so used in the future. Nonetheless, the groundwater beneath and directly downgradient of OU-3/IRP Site 21, and beneath and directly downgradient of the Hanscom AFB/Hanscom Field NPL Site as a whole, has been designated as GW-1 (i.e., as a potential future drinking water supply) under state law by means of a Town of Bedford Aquifer Protection District by-law that was enacted through a process authorized by MADEP and implemented through the state regulations (MCP). However, MADEP has classified the eastern end of Runway 11-29 on Hanscom Field, located north of the site, as a Non-Potential Drinking Water Source (Medium Yield); the MCP defines "Non-Potential Drinking Water Source" as, "Those portions of high and medium yield aquifers which may not be considered as areas of groundwater conducive to the locations of public water supplies." Nonetheless, MADEP has classified groundwater in this area as being of "high use and value." The MA DEP Site Scoring Map is included as Figure 2-10.

A well inventory was conducted for Hanscom AFB as part of the IRP Stage 2 Remedial Investigation for OU-3/IRP Site 6 by M&E (June 1992). The objective of the well inventory was to identify and locate all public water supply wells, private drinking water wells, and industrial, irrigation, and monitoring wells within a three-mile radius of Hanscom AFB. Hanscom AFB met with the Town of Bedford Board of Health Director in October 2000 to review the location of wells installed after the M&E survey. These surveys revealed that there are five private wells located within 1.4 miles of the northeastern corner of Hanscom AFB, in Bedford. The two private wells nearest to OU-3/IRP Site 21 are located 1.17 miles north-northeast, and 1.29 miles northeast of the site, respectively. The closest active public wells are the Town of Bedford Shawsheen Road Wellfield located approximately 12,000 feet northeast of IRP Site 21. Additionally, there is privately owned property northeast of the site between Kiln Brook and IRP Site 6 where private supply wells could be installed in the future. However, shallow groundwater most likely discharges to the Shawsheen River north of the site and there are no groundwater users between the site and the Shawsheen River. As mentioned previously, the contaminated groundwater at OU-3/IRP Site 21 does not appear to be adversely impacting the Shawsheen River. Therefore, there is limited potential for future use of site affected groundwater as a potable water supply downgradient from the site. Additionally, the concentrations of contaminants in groundwater at the assumed receptor location would be greatly reduced through fate and transport processes.

Community and stakeholder input was sought and incorporated through active outreach with the Restoration Advisory Board and the Bedford Board of Health.

2.7 Summary of Site Risks

A risk assessment was performed to estimate the probability and magnitude of potential adverse human health and environmental effects from exposure to contaminants associated with OU-3/IRP Site 21 assuming no additional remedial action was taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. The human health risk assessment followed a four step process: 1) hazard identification, which identified those hazardous substances which, given the specifics of the site were of significant concern; 2) exposure assessment, which identified actual or potential exposure pathways, characterized the potentially exposed populations, and determined the extent of possible exposure; 3) toxicity assessment, which considered the types and magnitude of adverse health effects associated with exposure to hazardous substances, and 4) risk characterization and uncertainty analysis, which integrated the three earlier steps to summarize the potential and actual risks posed by hazardous substances at the site, including carcinogenic and non-carcinogenic risks and a discussion of the uncertainty in the risk estimates. A summary of those aspects of the human health risk assessment which support the need for remedial action is discussed below followed by a summary of the environmental risk assessment.

2.7.1 Human Health Risk Assessment

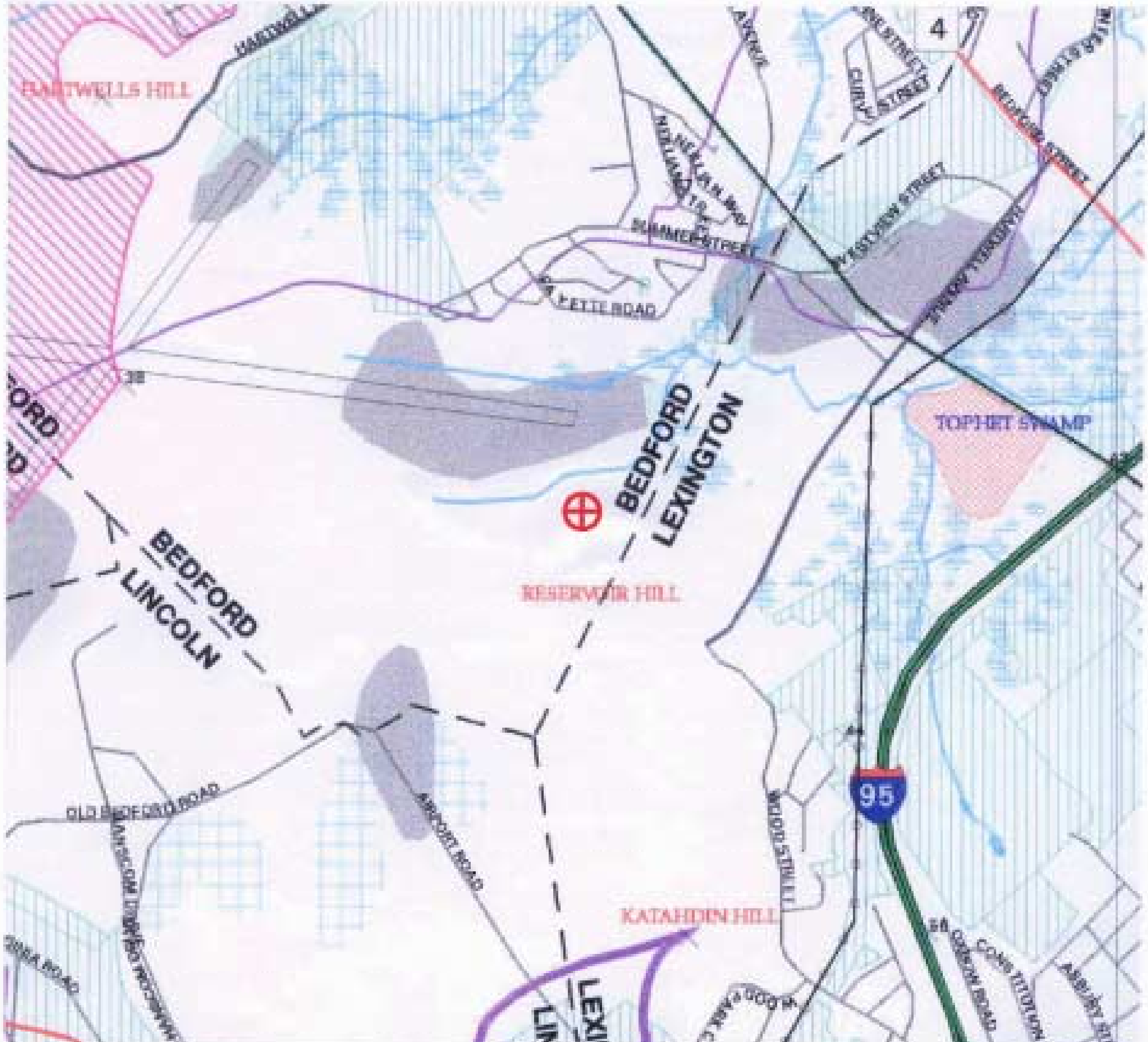
Chemicals of potential concern (COPCs) were selected for each medium for evaluation in the human health risk assessment. The chemicals of potential concern were selected to represent potential site related hazards based on toxicity, concentration, frequency of detection, and mobility and persistence in the environment. The COPCs can be found in Exhibit 5-2 of the Supplemental RI (CH2M HILL, 2000), however, there were no COPCs identified for quantitative evaluation in surface soil or off-site groundwater. From the list of COPCs, a subset of the chemicals was identified in the Feasibility Study as presenting a significant current or future risk and are referred to as the chemicals of concern in this ROD and summarized in Table C-1 in Appendix C – Human Health Risk Tables. This table contains the exposure point concentrations used to evaluate the reasonable maximum exposure scenario (RME) in the risk assessment for the COCs. No COPCs were retained as chemicals of concern (COCs) for on-site subsurface soil, therefore, this medium is not discussed in this human health risk summary.

Potential human health effects associated with exposure to the COPCs were estimated quantitatively or qualitatively through the development of several hypothetical exposure pathways. These pathways were developed to reflect the potential for exposure to hazardous substances based on the present uses, potential future uses, and location of the Site, though as stated above in Section 2.6, there are currently no plans to change the existing use of OU-3/Site 21 in the future. Table 2-5 above also summarizes the exposure pathway evaluation and describes which pathways are considered complete.

The following is a brief summary of just the exposure pathways that were found to present a significant risk. A more thorough description of all exposure pathways evaluated in the risk assessment, including estimates for an average exposure scenario, can be found in Section 5.1.6, Identification of Exposure Pathways in the Supplemental RI (CH2M HILL, 2000).

MA DEP – Bureau of Waste Site Cleanup

Quad 4



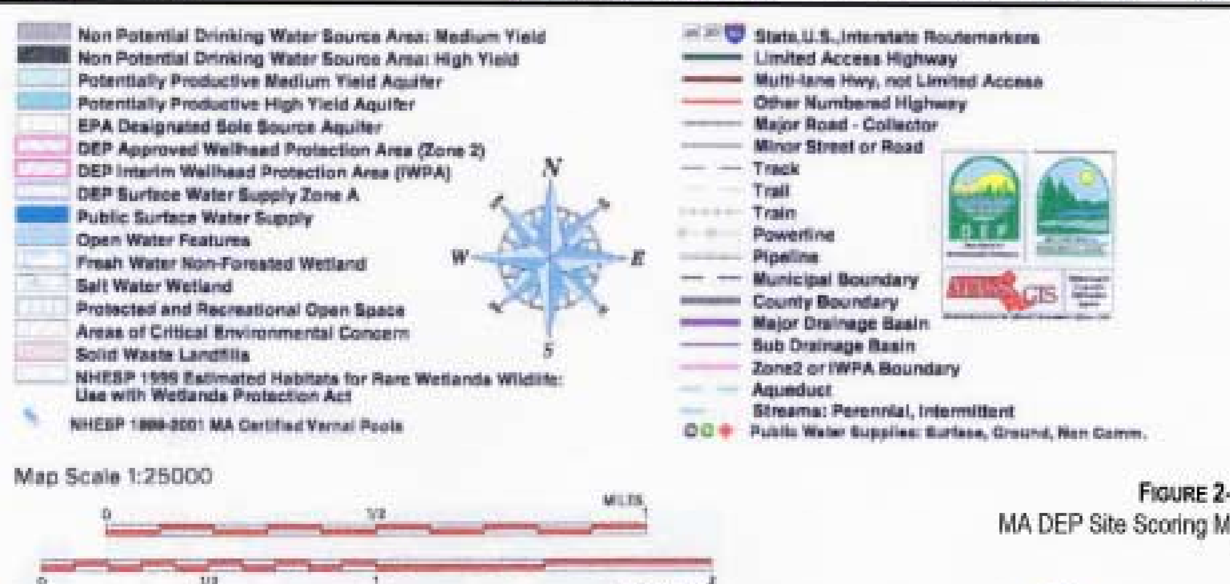


FIGURE 2-13
MA DEP Site Scoring Map

Two exposure pathways at OU-3/IRP Site 21 were found to present an unacceptable risk; exposure to groundwater by an on-site construction worker, and future residential exposure to groundwater. Groundwater is not used as a water supply at OU-3/IRP Site 21, or at the rest of Hanscom AFB, and is not expected to be used as a water supply in the near future. However, construction workers could contact the shallow groundwater during excavation activities. Exposure to on-site groundwater by future residents was evaluated as a hypothetical scenario.

For exposure of a construction worker to groundwater, inhalation of volatiles from groundwater was based on an inhalation rate of 2.5 m^3/hr for 8 hours/day, 100 days/year for 1 year. Dermal exposure to groundwater was based on a skin surface area of 5,300 cm^2 (includes head, hands, forearms, and lower legs). Skin permeability rates required for the calculation of dermal contact with groundwater were obtained from EPA dermal assessment guidance (EPA 1998a-SRI).

For future residential exposure to groundwater, ingestion of 1 L/day, 350 days/year for 6 years was presumed for a child, and 2 L/day, 350 days/year for 30 years for an adult. In accordance with the USEPA Region I guidance (USEPA, 1995a-SRI), the risk from the inhalation of volatiles from groundwater during showering was qualitatively assumed to equal the risk calculated for the ingestion of groundwater for VOCs. Therefore, it was not necessary to calculate an average daily intake for inhalation of volatiles from groundwater. Dermal exposure to groundwater was based on a skin surface area of 6,500 cm^2 for a child and 18,000 cm^2 for an adult.

Excess lifetime cancer risks were determined for each exposure pathway by multiplying a daily intake level with the chemical specific cancer potency factor. Cancer potency factors have been developed by USEPA from epidemiological or animal studies to reflect a conservative "upper bound" of the risk posed by potentially carcinogenic compounds. That is, the true risk is likely to be less than the risk predicted. The resulting risk estimates are expressed in scientific notation as a probability (e.g. 1×10^{-6} for one in one million or 1 in a 1,000,000). The probability means that an adult will have 1 in 1,000,000 (1×10^{-6}) increased risk of developing cancer over a lifetime as a result of site related exposure to the compounds at the stated concentrations. The increased risk of developing cancer due to exposure to the compounds is also termed ‘excess lifetime cancer risk’. The ‘excess’ means that the risk is in addition to the non-site lifetime risks as identified by the American Cancer Society, which are that, in the U.S., an individual has a lifetime risk of developing cancer as high as one in three. EPA’s generally acceptable risk range for site related exposure is 10^{-4} to 10^{-6}. Current EPA practice considers carcinogenic risks to be additive when assessing exposure to a mixture of hazardous substances. A summary of the cancer toxicity data relevant to the chemicals of concern is presented in Table C-2 in Appendix C – Human Health Risk Tables.

In assessing the potential for adverse effects other than cancer, a hazard quotient (HQ) is calculated by dividing the daily intake level by the reference dose (RfD) or other suitable benchmark. Reference doses have been developed by USEPA and they represent a level to which an individual may be exposed that is not expected to result in any deleterious effect. RfDs are derived from epidemiological or animal studies and incorporate uncertainty factors to help ensure that adverse health effects will not occur. A HQ < 1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that toxic noncarcinogenic effects from that chemical are unlikely. The Hazard Index (HI) is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g. liver) within or across those media to which the same individual may reasonably be exposed. A HI < 1 indicates that toxic noncarcinogenic effects are unlikely. A summary of the noncarcinogenic toxicity data relevant to the chemicals of concern is presented in Table C-3 in Appendix C.

Tables 2-6 through 2-10 depict the carcinogenic and non-carcinogenic risk summaries for the chemicals of concern in groundwater evaluated to reflect potential future ingestion, dermal contact, and inhalation by a child or adult during typical residential use, and dermal contact and inhalation by a construction worker during subsurface excavation corresponding to the reasonable maximum exposure (RME) scenario. Only those exposure pathways deemed relevant to the remedy being proposed are presented in this ROD. Readers are referred to section 5.1.9, Risk Characterization of the Supplemental RI (CH2M HILL, 2000) for a more comprehensive risk summary of all exposure pathways evaluated for all COPCs.

Several sources of uncertainty are associated with risk estimates as a result of the assumptions inherent in the risk assessment process. Some of the uncertainties associated with the OU-3/ IRP Site 21 risk assessment included:

- The data collected in 1997 and 1999 were validated before use in the risk assessment, and therefore, the uncertainty associated with analytical factors is assumed to be minimal. However, the 1992 data were not validated, and therefore, the uncertainty associated with these analytical data is slightly greater.
- Risks for one of the chemicals, 4-isopropyltoluene, were not quantified due to unavailable toxicity factors. Since there are no toxicity factors, there is no way to estimate additional site risk for this chemical. Since there is only one chemical without toxicity factors for the site, the overall risk from the site is not expected to be significantly higher.
- Overall for this risk assessment the combination of many conservative assumptions (i.e., in the exposure assessment and in the toxicity assessment) will most likely result in an over-estimate of risk at the site. It is unlikely the risk to human health is greater than what the risk assessment predicts, and it is most likely lower than the risk assessment indicates.

There are no unacceptable risks associated with exposure to OU-3/IRP Site 21 surface soil, subsurface soil, or off-site groundwater under current conditions. There may be a very slight noncarcinogenic hazard to an unprotected construction worker exposed to the shallow groundwater during any future excavation activities, if no health and safety precautions are taken (i.e. use of protective clothing). Additionally, based on extremely conservative exposure scenarios, there is an unacceptable risk associated with future residential potable use of groundwater beneath site. It is unlikely that this groundwater would ever be used as a drinking water source.

1,4-Dichlorobenzene, ethylbenzene, tetrachloroethene, toluene, and benzene were all detected at a maximum concentration in soil above the EPA Region 9 SSL for the soil to groundwater transport pathway. However, these constituents have all been detected in the groundwater and were all retained as COCs for direct contact with groundwater.

TABLE 2-6
Risk Characterization Summary – Carcinogens

Scenario Timeframe: Future Receptor Population: Resident Receptor Age: Child							
Medium	**Exposure Medium**	**Exposure Point**	**Chemical of Concern**	**Carcinogenic Risk**			
				Ingestion	**Inhalation[1]**	**Dermal**	**Exposure Routes Total**
Groundwater	On-site Ground-water	Tap Water	1,4-Dichlorobenzene	5.1×10^{-5}	5.1×10^{-5}	2.0×10^{-5}	1.2×10^{-4}
			Vinyl chloride	3.9×10^{-4}	3.9×10^{-4}	1.2×10^{-5}	7.8×10^{-4}
			Trichloroethene	3.6×10^{-7}	3.6×10^{-7}	3.6×10^{-8}	7.6×10^{-7}
			1,2-Dichloropropane	1.9×10^{-6}	1.9×10^{-6}	1.1×10^{-7}	3.8×10^{-6}
			Trans-1,3-Dichloropropene	7.9×10^{-7}	7.9×10^{-7}	2.6×10^{-8}	1.6×10^{-6}
			Tetrachloro-ethene	1.4×10^{-6}	1.4×10^{-6}	5.1×10^{-7}	3.4×10^{-6}
			Benzene	2.4×10^{-5}	2.4×10^{-5}	2.1×10^{-6}	5.0×10^{-5}
			Benzo(a) anthracene	8.0×10^{-7}	NA	6.1×10^{-6}	6.9×10^{-6}
			Benzo(b) fluoranthene	8.0×10^{-7}	NA	1.1×10^{-5}	1.1×10^{-5}
			Benzo(a) pyrene	4.0×10^{-6}	NA	5.2×10^{-5}	5.6×10^{-5}
			Indeno(1,2,3-cd)pyrene	4.0×10^{-7}	NA	9.4×10^{-6}	9.8×10^{-6}
						Groundwater risk total =	**1.0×10^{-3}**
						Total Risk =	**1.0×10^{-3}**

Key

1 : Inhalation risk equal to ingestion of VOCs only.

Notes:

This table provides risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of a child's exposure to groundwater under a residential use scenario, as well as the toxicity of the COCs. The total risk from direct exposure to groundwater to a child resident is estimated to be 1.0×10^{-3}. The COC contributing most to this risk is vinyl chloride. This risk level indicates that if no clean-up action is taken, an individual would have an increased probability of 1 in 1,000 of developing cancer as a result of site-related exposure to the COCs.

TABLE 2-7
Risk Characterization Summary – Carcinogens

Scenario Timeframe: **Future**

Receptor Population: **Resident**

Receptor Age: **Adult**

Medium	Exposure	Exposure Point	Chemical of Concern	Carcinogenic Risk			
				Ingestion	Inhalation[1]	Dermal	Exposure Routes Total
Ground-water	On-site Ground-water	Tap Water	1,4-Dichlorobenzene	1.1×10^{-4}	1.1×10^{-4}	6.1×10^{-5}	2.8×10^{-4}
			Vinyl chloride	8.3×10^{-4}	8.3×10^{-4}	3.5×10^{-5}	1.7×10^{-3}
			Trichloroethene	7.7×10^{-7}	7.7×10^{-7}	1.1×10^{-7}	1.7×10^{-6}
			1,2-Dichloropropane	4.0×10^{-6}	4.0×10^{-6}	3.3×10^{-7}	8.3×10^{-6}
			Trans-1,3-Dichloropropene	1.7×10^{-6}	1.7×10^{-6}	7.6×10^{-8}	3.5×10^{-6}
			Tetrachloroethene	3.1×10^{-6}	3.1×10^{-6}	1.5×10^{-6}	7.6×10^{-6}
			Benzene	5.1×10^{-5}	5.1×10^{-5}	6.3×10^{-6}	1.1×10^{-4}
			Benzo(a) anthracene	1.7×10^{-6}	NA	1.8×10^{-5}	2.0×10^{-5}
			Benzo(b) fluoranthene	1.7×10^{-6}	NA	3.1×10^{-5}	3.3×10^{-5}
			Benzo(a) pyrene	8.6×10^{-6}	NA	1.5×10^{-4}	1.6×10^{-4}
			Indeno(1,2,3-cd) pyrene	8.6×10^{-7}	NA	2.8×10^{-5}	2.9×10^{-5}
						Ground-water risk total =	2.3×10^{-3}
						Total Risk =	2.3×10^{-3}

Key

[1] : Inhalation risk equal to ingestion of VOCs only.

Notes:

This table provides risk estimates for the significant routes of exposure. These risk estimates are based on a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of an adult's exposure groundwater. The total risk from direct exposure to groundwater to an adult is estimated to be 2.3×10^{-3}. The COC contributing most to this risk is vinyl chloride. This risk level indicates that if no clean-up action is taken, an individual would have an increased probability of 2.3 in 1,000 of developing cancer as a result of site-related exposure to the COCs.

TABLE 2-8
Risk Characterization Summary – Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation	Dermal	Exposure Routes Total
Ground-water	Ground-water	Excavation	1,4-Dichlorobenzene	—	NA	3.1×10^{-4}	1.1×10^{-1}	1.1×10^{-1}
			1,2-Dichlorobenzene	—	NA	4.4×10^{-4}	1.3×10^{-1}	1.3×10^{-1}
			1,2,4-Trichlorobenzene	—	NA	2.5×10^{-5}	1.2×10^{-1}	1.2×10^{-1}
			cis-1,2-Dichloroethene	—	NA	NA	1.5×10^{-3}	1.5×10^{-3}
			Trichloroethene	—	NA	9.8×10^{-6}	2.3×10^{-3}	2.4×10^{-3}
			1,2-Dichloropropane	—	NA	2.6×10^{-4}	6.8×10^{-3}	7.1×10^{-3}
			Trans-1,3-Dichloropropene	—	NA	2.7×10^{-5}	2.2×10^{-4}	2.5×10^{-4}
			Tetrachloroethene	—	NA	8.0×10^{-6}	3.5×10^{-4}	3.6×10^{-4}
			Benzene	—	NA	1.9×10^{-3}	1.3×10^{-1}	1.3×10^{-1}
			Toluene	—	NA	3.2×10^{-3}	5.0×10^{-3}	8.2×10^{-3}
			Ethylbenzene	—	NA	4.1×10^{-4}	5.2×10^{-2}	5.2×10^{-2}
			meta-Xylene and para-Xylene	—	NA	NA	1.2×10^{-2}	1.2×10^{-2}
			Ortho-Xylene	—	NA	NA	4.1×10^{-3}	4.1×10^{-3}
			Isopropylbenzene	—	NA	1.2×10^{-4}	9.2×10^{-3}	9.3×10^{-3}
			n-Propylbenzene	—	NA	NA	1.3×10^{-1}	1.3×10^{-1}
			1,3,5-Trimethylbenzene	—	NA	1.8×10^{-2}	4.0×10^{-2}	5.8×10^{-2}
			12,4-Trimethylbenzene	—	NA	8.4×10^{-2}	1.9×10^{-1}	2.8×10^{-1}
			sec-butylbenzene	—	NA	NA	3.7×10^{-2}	3.7×10^{-2}
			Naphthalene	—	NA	3.5×10^{-2}	7.3×10^{-2}	1.1×10^{-1}
			2-Methylnaphthalene	—	NA	1.3×10^{-3}	5.3×10^{-3}	6.6×10^{-3}
Groundwater Hazard Index Total =								$1.2 \times 10^{+0}$
Receptor Hazard Index =								$1.2 \times 10^{+0}$

Key
— : Toxicity criteria are not available to quantitatively address this route of exposure.
NA : Not applicable.

Notes:

This table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of hazard quotients) for all routes of exposure. The Risk Assessment Guidance (RAGS) for Superfund states that, generally, a hazard index (HI) greater than 1 indicates the potential for adverse noncancer effects. The estimated HI of 1.2 indicates that the potential for adverse noncancer effects could occur from exposure to contaminated groundwater at the site.

TABLE 2-9
Risk Characterization Summary – Non-Carcinogens

Scenario Timeframe:	**Future**							
Receptor Population:	**Residential**							
Receptor Age:	**Child**							
Medium	**Exposure Medium**	**Exposure Point**	**Chemical of Concern**	**Primary Target Organ**	**Non-Carcinogenic Hazard Quotient**			
					Ingestion	**Inhalation**[1]	**Dermal**	**Exposure Routes Total**
Ground-water	Ground-water	Excavation	1,4-Dichlorobenzene	—	8.3×10^{-1}	8.3×10^{-1}	3.3×10^{-1}	$2.0 \times 10^{+0}$
			1,2-Dichlorobenzene	—	9.9×10^{-1}	9.9×10^{-1}	3.9×10^{-1}	$2.4 \times 10^{+0}$
			1,2,4-Trichlorobenzene	—	5.4×10^{-1}	5.4×10^{-1}	4.2×10^{-1}	$1.5 \times 10^{+0}$
			cis-1,2-Dichloroethene	—	6.4×10^{-1}	6.4×10^{-1}	3.4×10^{-2}	$1.3 \times 10^{+0}$
			Trichloroethene	—	6.4×10^{-2}	6.4×10^{-2}	6.4×10^{-3}	1.3×10^{-1}
			1,2-Dichloropropane	—	2.9×10^{-1}	2.9×10^{-1}	1.7×10^{-2}	6.0×10^{-1}
			Trans-1,3-Dichloropropene	—	1.7×10^{-1}	1.7×10^{-1}	5.5×10^{-3}	3.5×10^{-1}
			Tetrachloroethene	—	3.2×10^{-2}	3.2×10^{-2}	1.1×10^{-2}	7.5×10^{-2}
			Benzene	—	$3.2 \times 10^{+0}$	$3.2 \times 10^{+0}$	2.9×10^{-1}	$6.7 \times 10^{+0}$
			Toluene	—	5.8×10^{-1}	5.8×10^{-1}	1.2×10^{-1}	$1.3 \times 10^{+0}$
			Ethylbenzene	—	3.9×10^{-1}	3.9×10^{-1}	1.4×10^{-1}	9.2×10^{-1}
			meta-Xylene and para-Xylene	—	8.3×10^{-2}	8.3×10^{-2}	3.2×10^{-2}	2.0×10^{-1}
			Ortho-Xylene	—	2.9×10^{-2}	2.9×10^{-2}	1.1×10^{-2}	6.9×10^{-2}
			Isopropylbenzene	—	4.3×10^{-2}	4.3×10^{-2}	2.5×10^{-2}	1.1×10^{-1}
			n-Propylbenzene	—	5.6×10^{-1}	5.6×10^{-1}	3.6×10^{-1}	$1.5 \times 10^{+0}$
			1,3,5-Trimethylbenzene	—	2.0×10^{-1}	2.0×10^{-1}	1.1×10^{-1}	5.2×10^{-1}
			12,4-Trimethylbenzene	—	9.6×10^{-1}	9.6×10^{-1}	5.3×10^{-1}	$2.4 \times 10^{+0}$
			sec-butylbenzene	—	1.2×10^{-1}	1.2×10^{-1}	1.1×10^{-1}	3.4×10^{-1}
			Naphthalene	—	5.4×10^{-1}	NA	2.1×10^{-1}	7.6×10^{-1}
			2-Methylnaphthalene	—	2.0×10^{-2}	NA	1.8×10^{-2}	3.8×10^{-2}
							Groundwater Hazard Index Total =	$2.3 \times 10^{+1}$
							Receptor Hazard Index =	$2.3 \times 10^{+1}$

Key
— : Toxicity criteria are not available to quantitatively address this route of exposure.
NA : Not applicable.

Notes:
This table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of hazard quotients) for all routes of exposure. The Risk Assessment Guidance (RAGS) for Superfund states that, generally, a hazard index (HI) greater than 1 indicates the potential for adverse noncancer effects. The estimated HI of 23 indicates that the potential for adverse noncancer effects could occur to a child from exposure to contaminated groundwater at the site.

TABLE 2-10
Risk Characterization Summary – Non-Carcinogens

Scenario Timeframe: Future
Receptor Population: Residential
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Concern	Primary Target Organ	Non-Carcinogenic Hazard Quotient			
					Ingestion	Inhalation[1]	Dermal	Exposure Routes Total
Ground-water	Ground-water	Excavation	1,4-Dichlorobenzene	—	3.6×10^{-1}	3.6×10^{-1}	2.0×10^{-1}	9.1×10^{-1}
			1,2-Dichlorobenzene		4.3×10^{-1}	4.3×10^{-1}	2.3×10^{-1}	$1.1 \times 10^{+0}$
			1,2,4-Trichlorobenzene		2.3×10^{-1}	2.3×10^{-1}	2.5×10^{-1}	7.1×10^{-1}
			Cis-1,2-Dichloroethene	—	2.7×10^{-1}	2.7×10^{-1}	2.0×10^{-2}	5.7×10^{-1}
			Trichloroethene	—	2.7×10^{-2}	2.7×10^{-2}	3.8×10^{-3}	5.9×10^{-2}
			1,2-Dichloropropane	—	1.2×10^{-1}	1.2×10^{-1}	1.0×10^{-2}	2.6×10^{-1}
			Trans-1,3-Dichloropropene	—	7.3×10^{-2}	7.3×10^{-2}	3.3×10^{-3}	1.5×10^{-1}
			Tetrachloroethene	—	1.4×10^{-2}	1.4×10^{-2}	6.7×10^{-3}	3.4×10^{-2}
			Benzene	—	$1.4 \times 10^{+0}$	$1.4 \times 10^{+0}$	1.7×10^{-1}	$2.9 \times 10^{+0}$
			Toluene		2.5×10^{-1}	2.5×10^{-1}	7.1×10^{-2}	5.6×10^{-1}
			Ethylbenzene		1.7×10^{-1}	1.7×10^{-1}	8.2×10^{-2}	4.2×10^{-1}
			Meta-Xylene and para-Xylene		3.6×10^{-2}	3.6×10^{-2}	1.9×10^{-2}	9.0×10^{-2}
			Ortho-Xylene		1.2×10^{-2}	1.2×10^{-2}	6.6×10^{-3}	3.1×10^{-2}
			Isopropylbenzene		1.9×10^{-2}	1.9×10^{-2}	1.5×10^{-2}	5.2×10^{-2}
			n-Propylbenzene		2.4×10^{-1}	2.4×10^{-1}	2.1×10^{-1}	6.9×10^{-1}
			1,3,5-Trimethylbenzene	—	8.8×10^{-2}	8.8×10^{-2}	6.5×10^{-2}	2.4×10^{-1}
			1,2,4-Trimethylbenzene	—	4.1×10^{-1}	4.1×10^{-1}	3.1×10^{-1}	$1.1 \times 10^{+0}$
			sec-butylbenzene	—	4.9×10^{-2}	4.9×10^{-2}	6.8×10^{-2}	1.7×10^{-1}
			Naphthalene		2.3×10^{-1}	NA	1.3×10^{-1}	3.6×10^{-1}
			2-Methylnaphthalene	—	8.6×10^{-3}	NA	1.0×10^{-2}	1.9×10^{-2}
Groundwater Hazard Index Total =								$1.0 \times 10^{+1}$
Receptor Hazard Index =								$1.0 \times 10^{+1}$

Key
— : Toxicity criteria are not available to quantitatively address this route of exposure.
NA : Not applicable.

Notes:

This table provides hazard quotients (HQs) for each route of exposure and the hazard index (sum of hazard quotients) for all routes of exposure. The Risk Assessment Guidance (RAGS) for Superfund states that, generally, a hazard index (HI) greater than 1 indicates the potential for adverse noncancer effects. The estimated HI of 10 indicates that the potential for adverse noncancer effects could occur to an adult from exposure to contaminated groundwater at the site.

2.7.2 Ecological Risk Assessment

An Ecological Risk Assessment (ERA) was conducted to identify the risk that the COPCs may have upon ecological receptors in the vicinity of OU-3/IRP Site 21. This section summarizes the ERA that is presented in full in the Supplemental RI Report (CH2M HILL, 2000).

This ERA used a phased approach, consistent with the USEPA Ecological Risk Assessment Guidance for Superfund (USEPA, 1997), which consisted of:

- Problem Formulation
- Identification of Contaminants of Potential Concern
- Risk Questions
- Exposure and Effects Scenarios
- Risk Characterization

2.7.2.1 Problem Formation

During this phase of the ERA areas of ecological risk and receptors were identified. Since the contaminated soils identified at IRP Site 21 are generally well below the surface and thus a complete exposure pathway does not exist, site soils were not evaluated in the ERA. The Shawsheen River, located just north of the site, was identified as the only ecological resource at the site with a potentially completed exposure pathway.

The final selection of receptors for OU-3/IRP Site 21 included finfish as well as other pelagic organisms and sediment-dwelling organisms. Piscivorous birds, such as heron, which might feed on the fish could be at risk if site related chemicals which bioacumulate are identified at elevated levels in the sediment or water. Sediment-dwelling organisms are exposed directly to the media of concern (sediment and surface waters) within the Shawsheen River. This phase of the ERA included the creation of the Ecological Conceptual Site Model presented above as Figure 2-9.

2.7.2.2 Identification of Chemicals of Potential Concern

COPCs were identified using a series of steps. These steps involved identification of conservative ecological screening thresholds (concentrations of compounds shown in the literature to cause adverse ecological effects relevant to the appropriate assessment endpoint) for each medium and comparison of maximum media concentrations of detected contaminants to the screening thresholds through the use of hazard quotients (HQs), (the ratio of media concentrations to screening thresholds). Only the surface water and sediments in the Shawsheen River were evaluated for COPCs. The COPC selection process is presented in Tables D-1 and D-2 of Appendix D. The final step in determining COPCs for IRP Site 21 was to eliminate those chemicals which could not be considered site-related COPCs from the list carried through the risk assessment process thus far.

This screening process resulted in the elimination of most COPCs for each of the receptor groups. Only two compounds, benzo(b)fluoranthene and TPH, were considered final COPCs in surface water. The final COPCs for sediment included two SVOCs, (bis(2-ethylhexyl) phthalate and carbozole), three PAHs (benzo(a)anthracene, chrysene, and pyrene), and both diesel and gasoline range TPH. VOCs were not identified as COPCs for either sediment or surface water organisms.

2.7.2.3 Exposure and Effects Scenarios

The Exposure and Effects Scenarios phase of the ERA was performed for each COPC. This entailed determining whether and how receptor groups are exposed to COPCs and then characterizing the possible adverse effects for contaminant levels exceeding published toxic levels. Exposure pathways identified during the OU-3/IRP Site 21 ERA are presented below in Table 2-11.

TABLE 2-11
Ecological Exposure Pathways of Concern

Exposure Medium	Sensitive Environment Flag Y or N	Receptor	Endangered/ Threatened Species Flag Y or N	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Sediment	Y	Sediment-dwelling organisms	N	Absorption and ingestion of chemicals in sediment	Reduction in abundance or shift in dominance of sediment biota	Exceedance of sediment effects levels
Surface Water	Y	Finfish and other aquatic organisms	N	Absorption and ingestion of surface water.	Reduction in abundance or shift in dominance in finfish assemblages	Exceedance of Ambient Water Quality Criteria or similar benchmarks

2.7.2.4 Ecological Risk Characterization

In the Risk Characterization phase of the ERA, exposure concentrations determined from the exposure models were compared to values documented to cause adverse effects. The Screening Toxicity Values used in this process are presented for each of the final COPCs in Table 2-12, below.

2.7.2.5 ERA Conclusions

The results of the ecological risk assessment for the Shawsheen River indicate that potential risk to benthic organisms from bis (2-Ethylhexyl) phthalate, benzo(a)anthracene, chrysene and pyrene could not be ruled out. However, the degree of risk is not severe because the concentrations of these chemicals do not exceed their upper effects levels.

The potential risk to benthic and water column organisms could not be determined for TPH, benzo(b)fluoranthene, and carbozole, since effects levels were not available. However, at least some of the TPH and benzo(b)fluoranthene in the river seem to be originating from runoff from paved areas of the site and hence, is not likely related to historical releases at the site. A more detailed presentation of the Ecological Risk Assessment is given in the Supplemental RI report (CH2M HILL, 2000).

Furthermore, it is important to note that the RI and Supplemental RI sampling results indicate that the site's contaminants are not migrating into the river, either through groundwater discharge or through infiltration into the stormwater drainage system, and that the contaminants detected in the Shawsheen River are most likely from non-point sources such as stormwater runoff from the adjacent roads and runways.

TABLE 2-12
Ecological Risk Assessment - Screening Toxicity Values

Chemical of Potential Concern	Min. Conc. (ppb)	Max. Conc. (ppb)	Ave. Conc. (ppb)	Location Maximum Detection	Lower Threshold Value (ppb)	Threshold Value Source	HQ Value[1]	COC Flag Y or N
Exposure Medium: Sediment								
Bis(2-Ethylhexyl) phthalate	-	810	339	SWR6-02	182	D	4.45	Y
Carbazole	-	540	198	SWR6-02	-	-	-	Y
Benzo(a)anthracene	-	1100	490	SWR6-02	261	B	4.21	Y
Chrysene	-	2200	953	SWR6-02	384	B	5.73	Y
Pyrene	-	870	563	SWR6-02	665	B	1.31	Y
TPH, diesel range	-	360,000	177,000	SWR6-02	-	-	-	Y
TPH, gasoline range	-	110,000	64,000	SWR6-03	-	-	-	Y
Exposure Medium: Surface Water								
Benzo(a)fluoranthene	-	0.02	0.01	SWR6-01	-	-	-	Y
TPH, diesel range	-	150	54.8	SWR6-04	-	-	-	Y

Key:

Conc. = Concentration
- = Not Available
Averages were calculated using one-half the detection limit for non-detects
B = Effects Range Low, NOAA (Long and Morgan, 1991)
D = Threshold Effect Level, Florida DEP (MacDonald 1994)

Notes:
[1] Hazard Quotient (HQ) is defined as Maximum Concentration/ Screening Toxicity Value.

2.7.3 Basis for Response Action

It was determined that COC concentrations in OU-3/IRP Site 21 groundwater exceed federal drinking water standards (i.e., MCLs and non-zero MCLGs), state drinking water standards (i.e., MCLs) and state groundwater risk characterization standards (i.e., MCP Method 1 GW-1 standards), and the human health risk assessment revealed that future construction workers potentially exposed to LNAPL and contaminated groundwater, and future residential groundwater users may be exposed to an unacceptable human health risk that exceeds 10^{-4} (carcinogenic) and HI>1 (noncarcinogenic). Thus, actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

The ecological risk assessment revealed that although a risk could not be ruled out, the contamination is not related to the releases regulated under CERCLA and actions to address the Clean Water Act are outside the purview of CERCLA and this ROD. However, the headwaters of the Shawsheen River which includes Hanscom AFB and Hanscom Field are the subject of intensive study through the Massachusetts Watershed Initiative established to ensure Clean Water Act compliance. However, it should also be noted, that actions to ensure that the site's contaminants are not impacting the Shawsheen River are subject to CERCLA and are included in the remedial action presented in this ROD.

2.8 Remedial Action Objectives

Based on information relating to types of contaminants, environmental media of concern, and potential exposure pathways, remedial action objectives (RAOs) were developed to aid in the development and screening of alternatives during the feasibility study. These RAOs were developed to mitigate, restore and/or prevent existing and future potential threats to human health and the environment. The RAOs for the selected remedy for OU-3/IRP Site 21 are:

- Prevent exposure (via ingestion, inhalation and/or dermal contact) to groundwater containing COC concentrations that exceed federal drinking water standards (i.e., MCLs and non-zero MCLGs), state drinking water standards (i.e., MCLs) and state groundwater risk characterization standards (i.e., MCP Method 1 GW-1 standards);
- Prevent discharge to the Shawsheen River of groundwater containing COC concentrations that exceed federal drinking water standards, state drinking water standards and state groundwater risk characterization standards;
- Prevent or minimize further migration of the contaminant plume (dissolved-phase COCs);
- Prevent or minimize further migration of contaminants from source materials (VOCs/LNAPL) to groundwater; and
- Within an acceptable time period (< 100 years), return groundwaters to federal drinking water standards (i.e., MCLs and non-zero MCL goals (MCLGs)), state drinking water standards (i.e., MCLs) and state groundwater risk characterization standards (i.e., MCP Method 1 GW-1 standards).

The RAOs are meant to reduce the potential exposure of future construction workers to groundwater contamination via dermal contact and inhalation that may present a human health risk in excess of 10^{-4} (carcinogenic) and HI >1 (noncarcinogenic) such that the risk attributable to this medium is below 10^{-4} to 10^{-6} (carcinogenic) and has a HI which does not exceed one (noncarcinogenic) and complies with the applicable or relevant appropriate requirements (ARARs) for the protection of human health and the environment.

In addition, the RAOs are meant to reduce the potential exposure of children and adults to groundwater contaminants via ingestion, dermal contact, and inhalation that may present at a human health risk in excess of 10^{-4} (carcinogenic) and HI >1 (noncarcinogenic) such that the risk attributable to this medium is below 10^{-4} to 10^{-6} (carcinogenic) and has a HI which does not exceed one (noncarcinogenic) and complies with ARARs for the protection of human health and the environment.

2.9 Development and Screening of Alternatives

2.9.1 Statutory Requirements/Response Objectives

Under its legal authorities, USEPA's primary responsibility at Superfund sites is to ensure that remedial actions are protective of human health and the environment. In addition, Section 121 of CERCLA establishes several other statutory requirements and preferences, including: a requirement that Air Force's remedial action, when complete, must comply with all federal and more stringent state environmental and facility siting standards, requirements, criteria or limitations, unless a waiver is invoked; a requirement that Air Force select a remedial action that is cost-effective and that utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and a preference for remedies in which treatment which permanently and significantly reduces the volume, toxicity or mobility of the hazardous substances is a principal element over remedies not involving such treatment. Response alternatives were developed to be consistent with these Congressional mandates.

2.9.2 Technology and Alternative Development and Screening

CERCLA and the NCP set forth the process by which remedial actions are evaluated and selected. In accordance with these requirements, a range of alternatives were developed for the site.

With respect to source control, the FS developed a range of alternatives in which removal and or treatment that reduces the toxicity, mobility, and/or volume of the hazardous substances (LNAPL and groundwater) is a principal element. This range included an alternative (Alternative 12 – the selected remedy) that removes or destroys the LNAPL and groundwater contamination to the maximum extent feasible, eliminating or minimizing to the degree possible the need for long term management. This range also included alternatives that included less aggressive approaches to removal and/or treatment of the LNAPL and contaminated groundwater and varied in the quantities and characteristics of the treatment residuals and untreated waste that must be managed; alternatives that involved less or no removal and/or treatment but provided protection through LUCs/ICs; and a no action alternative.

As discussed in Section 3.3 of the FS, LNAPL and groundwater treatment technology options were identified, assessed and screened based on implementability, effectiveness, and cost. The purpose of the initial screening was to narrow the number of potential remedial actions for further detailed analysis while preserving a range of options. Alternatives retained during the initial screening were then evaluated in detail in Section 4.3 of the FS. In summary, of the 12 alternatives screened in Section 3.3, 4 were retained for detailed analysis in Section 4.3 as possible options for the cleanup of the Site.

2.10 Description of Alternatives

Each remedy discussed in this section was designed to address threats posed by the LNAPL and contaminated groundwater found below OU-3/IRP Site 21. The remedial remedies considered, including the no action remedy, are summarized below. A more complete, detailed presentation of each remedy is found in Section 4.3 of the FS.

OU-3/IRP Site 21 LNAPL and Groundwater Remedies

The remedial alternatives selected for detailed analysis for the OU-3/IRP Site 21 LNAPL and groundwater are as follows:

- Alternative 1—No Action
- Alternative 9—Interceptor Trench with Passive Recovery Wells near Northern Boundary; Passive Recovery Well Network throughout LNAPL Pool C; Monitoring and LUCs/ICs
- Alternative 10 –Interceptor Trench with Passive Recovery Wells near Northern Boundary; ORC® Application in Trench; Passive Recovery Well Network throughout LNAPL Pool C; Monitoring and LUCs/ICs; and Groundwater Containment/Treatment Contingencies
- Alternative 11—Interceptor Trench with Passive Recovery Wells near Northern Boundary; ORC® Application in Trench; In-Situ Oxidation of LNAPL Pool C; Monitoring and LUCs/ICs; and Groundwater Containment/ Treatment Contingencies
- Alternative 12— Interceptor Trenches with Passive Recovery Wells near Northern Boundary and at 2 Hotspot Areas within LNAPL Pool C; ORC® Application in Trenches; Enhanced Recovery Wells at Non-hotspot Areas of LNAPL Pool C; Monitoring and LUCs/ICs; and Groundwater Containment/Treatment and VER Contingencies

Table 2-13 summarizes the five remedies evaluated in detail in the FS.

2.10.1 Alternative 1 — No Action

Description of No Action Remedy

Under this alternative, no further effort or resources would be expended at the Hanscom AFB OU-3/IRP Site 21 site. This alternative does not include any additional groundwater monitoring. It is impossible at this time to predict when the Remedial Action Objectives would be met under this alternative, and, in fact, they may never be met under this alternative. However, if natural attenuation does occur, then the TTCU tool estimated that it will take well over 100 years to achieve RAOs.

Because contaminated media would be left on the site, a review of the site conditions would be required every 5 years in accordance with CERCLA and the NCP. Alternative 1 serves as the baseline against which the effectiveness of other remedies is judged.

2.10.2 Alternative 9— Interceptor Trench with Passive Recovery Wells near Northern Boundary; Passive Recovery Well Network throughout LNAPL Pool C; Monitoring and LUCs/ICs

Description of Alternative 9

This alternative would involve the installation of an interceptor trench with passive recovery wells in LNAPL Pools A and B near the northern boundary of the site. During construction of the trench, petroleum saturated soils would be removed. Under this alternative, passive product recovery wells would also be installed in the area of LNAPL Pool C. LNAPL flowing into the recovery wells would be removed by product removal systems such as manually emptied recovery devices (bailers), oil absorbent materials, oliphatic filter recovery devices, product-only pumps, belt skimming systems, or automatic emptying recovery devices.

TABLE 2-13
Information Summary for the 5 Remedies

Remedial Alternative	Long Term Reliability	Untreated Waste	Time for Design, Construction, and/or Implementation (yrs)	Time to Reach Remediation Goals (yrs)	Costs	Expected Outcome
Alternative 1	NA	No treatment undertaken. Therefore, all contaminants remain onsite.	0	>100 yrs	Capital = $0 O&M = $0 5 yr reviews = $15,000 each Total present worth = $59,000 Discount rate = 5% Yrs remedy cost projected over = 100	No use of groundwater and no change in land use in the foreseeable future.
Alternative 9	Reliable, includes permanent removal of LNAPL, and trench has a long estimated lifespan.	The groundwater contaminant plume will not be contained or treated under this alternative.	0-1	>100 yrs	Capital = $872,000 O&M = $19,500 per year 5 yr reviews = $15,000 each Total present worth = $1.36 million Discount rate = 5% Yrs remedy cost projected over = 100	No use of groundwater and no change in land use in the foreseeable future. Risks to human health will be eliminated over time.
Alternative 10	Reliable, includes permanent removal of LNAPL, and trench has a long estimated lifespan.	None, product and groundwater contained/captured under this alternative.	0-1	>100 yrs	Capital = $892,000 O&M = $19,500 per year 5 yr reviews = $15,000 each Total present worth = $1.38 million Discount rate = 5% Yrs remedy cost projected over = 100	No use of groundwater and no change in land use in the foreseeable future. Risks to human health will be eliminated over time.
Alternative 11	Reliable, includes permanent removal of LNAPL, and trench has a long estimated lifespan.	None, product and groundwater contained/captured under this alternative.	0-1	50 to 100 yrs	Capital = $1.56 million O&M = $19,500 per year 5 yr reviews = $15,000 each Total present worth = $2.04 million Discount rate = 5% Yrs remedy cost projected over = 75	No use of groundwater and no change in land use in the foreseeable future. Risks to human health will be eliminated over time.
Alternative 12	Reliable, includes permanent removal of LNAPL, and trenches have a long estimated lifespan.	None, this alternative involves the most aggressive treatment of product and groundwater contamination.	0-1	25 to 50 yrs	Capital = $1.02 million O&M = $28,000 per year 5 yr reviews = $15,000 each Total present worth = $1.57 million Discount rate = 5% Yrs remedy cost projected over = 35	No use of groundwater and no change in land use in the foreseeable future. Risks to human health will be eliminated over time.

In addition, a groundwater sampling and analysis program would be implemented to monitor the reduction in the volume of LNAPL and the natural attenuation/natural containment of the LNAPL and dissolved-phase contaminant (VOCs and fuel compounds) plumes. Also LUCs/ICs would be put in place to ensure that groundwater is not used for human consumption and that future land use does not increase the risk of exposure to the contamination remaining on-site. LUCs/ICs are administrative mechanisms which are considered acceptable to control exposure to on-site LNAPL and contaminated groundwater. LUCs/ICs have already been partially instituted in that IRP Site 21 is shown in the Hanscom Air Force Base General Plan (master plan) as an area of the base with "Environmental Constraints" and base operating procedures as defined by Air Force Instructions requires that project planning documents (for both new construction and repair projects) be coordinated with the environmental office. Also groundwater from OU-3/IRP Site 21, or from anywhere else on Hanscom AFB, is not used as a water supply and is not expected to be used as a water supply anytime in the future. These LUCs/ICs will be enhanced by amending the General Plan to add the specific environmental constraints (LUCs/ICs) that apply to IRP Site 21 site and by issuing periodic Memorandums to Hanscom AFB project originators emphasizing the Air Force's requirement that project planning documents (for both new construction and repair projects) be coordinated with the environmental office. Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure (and groundwater and/or land use restrictions are necessary), a review will be conducted by the Air Force within five years after initiation of remedial action to assure that the remedy continues to provide adequate protection of human health and the environment. Five-year reviews will continue as long as hazardous substances remain on-site above levels that allow unrestricted exposure and unlimited use.

This alternative includes the following major components:

- Installation of a product recovery trench running east to west through LNAPL Pool A (MWZ-9 and MWZ-10) then turning southwest toward LNAPL Pool B and running just east of ECS-33 ending approximately 50 feet southeast of ECS-33. During trench excavation, contaminated capillary and saturated zone soils would be removed and the trench would be backfilled with gravel. The gravel would create a migration pathway within the trench to aid in product recovery. Vertical passive product recovery wells would be installed/spaced along the length of the interceptor trench. Residual LNAPL which flows into the interceptor trench recovery wells would be removed by product removal systems as described below.
- Removal and disposal/recycling/on-site treatment of petroleum saturated soils during trench excavation in LNAPL Pools A and B.
- Installation of passive product recovery wells in LNAPL Pool C.
- LNAPL recovery systems in the recovery wells, such as manually emptied recovery devices (bailers), oil absorbent materials, oliphatic filter recovery devices, product removal pumps, belt skimming systems, or automatic emptying recovery devices.

2.10.3 Alternative 10 – Interceptor Trench with Passive Recovery Wells near Northern Boundary; ORC® Application in Trench; Passive Recovery Well Network throughout LNAPL Pool C; Monitoring and LUCs/ICs; and Groundwater Containment/Treatment Contingencies

Description of Alternative 10

This alternative is similar to Alternative 9 with additional measures to contain and remediate the dissolved-phase plume in Zone 4. These include the application of ORC® during the construction of the interceptor trench and contingency options for groundwater containment and/or treatment.

ORC® is a patented product consisting of magnesium peroxide and phosphate that enhances biodegredation of dissolved phase (VOCs and fuel compounds) contaminants by introducing a slow-release oxygen source directly into the contaminated groundwater. In the subsurface environment oxygen is typically limited resulting in slow rates of biodegradation. ORC® can either be applied directly as a powder (e.g., at the base of an excavation) or injected to the subsurface as a slurry down boreholes or injection wells. Under this alternative ORC® powder would be applied directly to the base of the excavation during the construction of the trench.

In addition, the product recovery wells installed in the trench will be designed for contingency use as a groundwater pump and treat system or for ORC® injection should downgradient monitoring indicate that groundwater containment or treatment is needed. Groundwater containment/treatment would be accomplished by pumping groundwater from the interceptor trench. The collected ground water would pumped through a treatment system already on-site that was used for the Removal Action. Injecting ORC® in the trench would create a treatment barrier that would intercept the downgradient migration of dissolved-phase contaminants.

Similar to Alternative 9, LNAPL flowing into the passive product recovery wells in the intercepter trenches in LNAPL Pool C would be removed by product removal systems as described in Alternative 9 above.

This alternative includes the following major components:

- Installation of a product recovery trench running east to west through LNAPL Pool A (MWZ-9 and MWZ-10) then turning southwest toward LNAPL Pool B and running just east of ECS-33 ending approximately 50 feet southeast of ECS-33. During trench excavation, contaminated capillary and saturated zone soils would be removed and the trench would be backfilled with ORC® powder and gravel. The ORC® powder would be applied to the trench bottom to treat dissolved-phase groundwater contamination. The gravel would create a migration pathway within the trench to aid in product recovery. Vertical passive product recovery wells would be installed/spaced along the interceptor trench. Residual LNAPL which flows into the interceptor trench recovery wells would be removed by product removal systems as described below.
- Removal and disposal/recycling/on-site treatment of petroleum saturated soils during trench excavation in LNAPL Pools A and B.
- Installation of passive product recovery wells in LNAPL Pool C.

- LNAPL recovery systems in the recovery wells, such as manually emptied recovery devices (bailers), oil absorbent materials, oliphatic filter recovery devices, product removal pumps, belt skimming systems, or automatic emptying recovery devices.
- As a contingency, the interceptor trench product recovery wells would be designed for the installation of pumps and a water treatment system for dissolved-phase plume containment and/or treatment at a later date. The groundwater treatment system would consist of an oil-water separator, sand filter, and granular activated carbon canisters. Hanscom AFB already has such a system on site that could be used.
- Design of the interceptor trench product recovery wells for contingency use as ORC® injection wells in order to create a groundwater treatment barrier.

In addition, a groundwater sampling and analysis program would be implemented to monitor the reduction in the volume of LNAPL and the natural attenuation/natural containment of the LNAPL and dissolved-phase (VOCs and fuel compounds) contaminant plumes. Also LUCs/ICs would be put in place to ensure that groundwater is not used for human consumption and that future land use does not increase the risk of exposure to the contamination remaining on-site. LUCs/ICs are administrative mechanisms which are considered acceptable to control exposure to on-site LNAPL and contaminated groundwater. LUCs/ICs have already been partially instituted in that IRP Site 21 is shown in the Hanscom Air Force Base General Plan (master plan) as an area of the base with "Environmental Constraints" and base operating procedures as defined by Air Force Instructions requires that project planning documents (for both new construction and repair projects) be coordinated with the environmental office. Also groundwater from OU-3/IRP Site 21, or from anywhere else on Hanscom AFB, is not used as a water supply and is not expected to be used as a water supply anytime in the future. These LUCs/ICs will be enhanced by amending the General Plan to add the specific environmental constraints (LUCs/ICs) that apply to IRP Site 21 site and by issuing periodic Memorandums to Hanscom AFB project originators emphasizing the Air Force's requirement that project planning documents (for both new construction and repair projects) be coordinated with the environmental office. Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure (and groundwater and/or land use restrictions are necessary), a review will be conducted by the Air Force within five years after initiation of remedial action to assure that the remedy continues to provide adequate protection of human health and the environment. Five-year reviews will continue as long as hazardous substances remain on-site above levels that allow unrestricted exposure and unlimited use.

2.10.4 Alternative 11 – Interceptor Trench with Passive Recovery Wells near Northern Boundary; ORC® Application in Trench; Passive Recovery Well Network throughout LNAPL Pool C; Monitoring and LUCs/ICs; and Groundwater Containment/Treatment Contingencies

Description of Alternative 11

This alternative is similar to Alternative 10, however, instead of passive product recovery wells, in-situ oxidation would be used to actively treat LNAPL Pool C. In-situ oxidation involves the injection of chemical reagents into the groundwater and capillary fringe to oxidize the LNAPL and dissolved-phase (VOCs and fuel compounds) contaminants into carbon dioxide and water. The oxidants commonly used include hydrogen peroxide, permanganate, and ozone. The reagent would be injected as a liquid into the subsurface through injection points located in LNAPL Pool C.

This alternative includes the following major components:

- Installation of a product recovery trench running east to west through LNAPL Pool A (MWZ-9 and MWZ-10) then turning southwest toward LNAPL Pool B and running just east of ECS-33 ending approximately 50 feet southeast of ECS-33. During trench excavation, contaminated capillary and saturated zone soils would be removed and the trench would be backfilled with ORC® powder and gravel up to the water table. The ORC® powder would be applied to the trench bottom to treat dissolved-phase groundwater contamination. The gravel would create a migration pathway within the trench to aid in product recovery. Vertical passive product recovery wells would be installed/spaced along the interceptor trench. Residual LNAPL which flows into the interceptor trench recovery wells would be removed by product removal systems as described below.
- Removal and disposal/recycling/on-site treatment of petroleum saturated soils during trench excavation in LNAPL Pools A and B.
- LNAPL recovery systems in the recovery wells, such as manually emptied recovery devices (bailers), oil absorbent materials, oliphatic filter recovery devices, product removal pumps, belt skimming systems, or automatic emptying recovery devices.
- As a contingency, the interceptor trench product recovery wells would be designed for the installation of pumps and a water treatment system for dissolved-phase plume containment and/or treatment at a later date. The groundwater treatment system would consist of an oil-water separator, sand filter, and granular activated carbon canisters. Hanscom AFB already has such a system on site that could be used.
- Design of the interceptor trench product recovery wells for contingency use as ORC® injection wells in order to create a groundwater treatment barrier.
- Installation of in-situ oxidation injection wells and application of oxidation reagents to treat LNAPL Pool C.

In addition, a groundwater sampling and analysis program would be implemented to monitor the reduction in the volume of LNAPL and the natural attenuation/natural containment of the LNAPL and dissolved-phase (VOCs and fuel compounds) contaminant plume. Also LUCs/ICs would be put in place to ensure that groundwater is not used for human consumption and that future land use does not increase the risk of exposure to the contamination remaining on-site. LUCs/ICs are administrative mechanisms which are considered acceptable to control exposure to on-site LNAPL and contaminated groundwater. LUCs/ICs have already been partially instituted in that IRP Site 21 is shown in the Hanscom Air Force Base General Plan (master plan) as an area of the base with "Environmental Constraints" and base operating procedures as defined by Air Force Instructions requires that project planning documents (for both new construction and repair projects) be coordinated with the environmental office. Also groundwater from OU-3/IRP Site 21, or from anywhere else on Hanscom AFB, is not used as a water supply and is not expected to be used as a water supply anytime in the future. These LUCs/ICs will be enhanced by amending the General Plan to add the specific environmental constraints (LUCs/ICs) that apply to IRP Site 21 site and by issuing periodic Memorandums to Hanscom AFB project originators emphasizing the Air Force's requirement that project planning documents (for both new construction and repair projects) be coordinated with the environmental office. Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure (and groundwater and/or land use restrictions are necessary), a review will be conducted by the Air Force within five years after initiation of remedial action to assure that the remedy continues to provide adequate protection of human health and the environment. Five-year reviews will continue as long as hazardous substances remain on-site above levels that allow unrestricted exposure and unlimited use.

2.10.5 Alternative 12 – Interceptor Trenches with Passive Recovery Wells near Northern Boundary and at 2 Hotspot Areas within LNAPL Pool C; ORC® Application in Trenches; Enhanced Recovery Well Network at Non-hotspot Areas of LNAPL Pool C; Monitoring and LUCs/ICs; and Groundwater Containment/ Treatment and Contingencies

Description of Alternative 12

This alternative is similar to Alternative 10 with the construction of additional interceptor trenches in two of the LNAPL Pool C "hotspots" located in Zones 1 and 2. In addition, product recovery from wells within LNAPL Pool C will be enhanced by the pumping of groundwater from the wells to create a zone of depression at the recovery point. The alternative also includes an additional contingency for use of vacuum enhanced recovery within the area of LNAPL Pool C. Also ORC® will be added to the hotspot trenches during their construction to aid in the biodegradation of dissolved-phase (VOCs and fuel compounds) contamination and provisions will be included in the design/installation of product recovery wells in the trenches so that they could be used for groundwater containment (pump & treat) or as an ORC® treatment barrier should downgradient monitoring indicate that containment or treatment is needed.

This alternative includes the following major components:

- Installation of a product recovery trench running east to west through LNAPL Pool A (MWZ-9 and MWZ-10) then turning southwest toward LNAPL Pool B and running just east of ECS-33 ending approximately 50 feet southeast of ECS-33. Two additional trenches would be installed in LNAPL Pool C, both running east to west. One would be between MWZ-21 and MWZ-17 and the second would be between MWZ-20 and MWZ-18. During trench excavations, contaminated capillary and saturated zone soils would be removed and the trenches would be backfilled with ORC® powder and gravel. The ORC® powder would be applied to the trench bottoms to treat dissolved-phase groundwater contamination. The gravel would create migration pathways within the trenches to aid in product recovery. Vertical passive product recovery wells would be installed/spaced in each interceptor trench. Residual LNAPL that flows into the interceptor trench recovery wells would be removed by product removal systems as described below.

- Removal and disposal/recycling/on-site treatment of petroleum saturated soils during trench excavation in LNAPL Pools A, B and C.

- As a contingency, the interceptor trenches' product recovery wells would be designed for the installation of pumps and a water treatment system for dissolved-phase plume containment and/or treatment at a later date. The groundwater treatment system would consist of an oil-water separator, sand filter, and granular activated carbon canisters. Hanscom AFB already has such a system on site that could be used.

- Design of the interceptor trenches' product recovery wells for contingency use such as ORC® injection wells in order to create a groundwater treatment barrier.
- Installation of enhanced product wells elsewhere in LNAPL Pool C. A pump would be installed in each well to lower the water table and draw in the product. The effluent from the pumps would be piped to the existing groundwater treatment system which consists of an oil-water separator, sand filter, and granular activated carbon canisters.
- As a contingency, the product recovery wells network within LNAPL Pool C would be designed so that they could be converted to vacuum enhanced recovery (VER) wells should monitoring indicate that additional contaminant mass removal would be required to achieve RAOs in a timely manner.

In addition, a groundwater sampling and analysis program would be implemented to monitor the reduction in the volume of LNAPL and the natural attenuation natural containment of the LNAPL and dissolved-phase (VOCs and fuel compounds) contaminant plumes. Also LUCs/ICs would be put in place to ensure that groundwater is not used for human consumption and that future land use does not increase the risk of exposure to the contamination remaining on-site. LUCs/ICs are administrative mechanisms which are considered acceptable to control exposure to on-site LNAPL and contaminated groundwater. LUCs/ICs have already been partially instituted in that IRP Site 21 is shown in the Hanscom Air Force Base General Plan (master plan) as an area of the base with "Environmental Constraints" and base operating procedures as defined by Air Force Instructions requires that project planning documents (for both new construction and repair projects) be coordinated with the environmental office. Also groundwater from OU-3/IRP Site 21, or from anywhere else on Hanscom AFB, is not used as a water supply and is not expected to be used as a water supply anytime in the future. These LUCs/ICs will be enhanced by amending the General Plan to add the specific environmental constraints (LUCs/ICs) that apply to IRP Site 21 site and by issuing periodic Memorandums to Hanscom AFB project originators emphasizing the Air Force's requirement that project planning documents (for both new construction and repair projects) be coordinated with the environmental office. Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure (and groundwater and/or land use restrictions are necessary), a review will be conducted by the Air Force within five years after initiation of remedial action to assure that the remedy continues to provide adequate protection of human health and the environment. Five-year reviews will continue as long as hazardous substances remain on-site above levels that allow unrestricted exposure and unlimited use.

2.11 Summary of the Comparative Analysis of Alternatives

Section 121(b)(1) of CERCLA presents several factors that at a minimum the USAF is required to consider in its assessment of alternatives. Building upon these specific statutory mandates, the NCP articulates nine evaluation criteria to be used in assessing the individual remedial alternatives.

2.11.1 Nine Evaluation Criteria

A detailed analysis was performed on the alternatives using the nine evaluation criteria in order to select a site remedy. The following is a summary of the comparison of each alternative's strength and weakness with respect to the nine evaluation criteria. These criteria are summarized as follows:

2.11.1.1 Threshold Criteria

The two threshold criteria described below must be met in order for the alternatives to be eligible for selection in accordance with the NCP:

1. **Overall protection of human health and the environment** addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced or controlled through treatment, engineering controls, or institutional controls.
2. **Compliance with applicable or relevant and appropriate requirements (ARARs)** addresses whether or not a remedy will meet all Federal environmental and more stringent State environmental and facility siting standards, requirements, criteria or limitations, unless a waiver is invoked.

2.11.1.2 Primary Balancing Criteria

The following five criteria are utilized to compare and evaluate the elements of one alternative to another that meet the threshold criteria:

1. **Long-term effectiveness and permanence** addresses the criteria that are utilized to assess alternatives for the long-term effectiveness and permanence they afford, along with the degree of certainty that they will prove successful.
2. **Reduction of toxicity, mobility, or volume through treatment** addresses the degree to which alternatives employ recycling or treatment that reduces toxicity, mobility, or volume, including how treatment is used to address the principal threats posed by the site.
3. **Short term effectiveness** addresses the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until cleanup goals are achieved.
4. **Implementability** addresses the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.
5. **Cost** includes estimated capital and Operation Maintenance (O&M) costs, as well as present-worth costs.

2.11.1.3 Modifying Criteria

The modifying criteria are used as the final evaluation of remedial alternatives, generally after USEPA has received public comment on the RI/FS and Proposed Plan:

1. **State acceptance** addresses the State's position and key concerns related to the preferred alternative and other alternatives, and the State's comments on ARARs or the proposed use of waivers.

2. **Community acceptance** addresses the public's general response to the alternatives described in the Proposed Plan and RI/FS report.

2.11.2 Time to Cleanup Model

To support the alternatives evaluation a computer model was used to estimate the approximate time it would take to reach the RAOs under select alternatives. The model, developed by CH2M HILL and referred to as the Time to Clean Up (TTCU) tool, is a source area model which estimates the time required for soluble fractions of residual and free-phase (liquid) NAPL to naturally attenuate.

The spreadsheet model calculates changes in the hydrocarbon concentrations in NAPL-contaminated source area soils (smear zone soils) and groundwater during natural attenuation. The model constantly re-calculates the dissolved equilibrium concentration of each hydrocarbon fraction as hydrocarbons are removed through dissolution and transport in the groundwater, and through biodegradation. The model results are presented on graphs showing groundwater concentrations for specified contaminants over time which are then used to estimate the time required to reach contaminant concentration goals.

Groundwater sampling results from the 1999 Supplemental RI indicate that only PAHs continue to exceed the ARARs in groundwater beneath LNAPL Pool C. The more volatile constituents appear to have either naturally attenuated or more likely been removed by the dual-phase recovery and SVE systems historically used at IRP Site 21. Although free product is observed in a number of monitoring wells in this area, the groundwater concentrations reveal that the product consists mainly of heavier hydrocarbons. Therefore, the model was set up to estimate the time required for dissolved-phase concentrations of 1,2,4-trimethylbenzene and naphthalene, two of the contaminants currently exceeding groundwater standards, to decrease below ARARs. Review of the modeling results can also be used to estimate the time required for the majority of the free-phase (liquid) LNAPL to be attenuated.

The TTCU tool was run several times varying the amount of the contaminant mass that would be removed by a remedial action to provide a range of clean-up times which then could be matched to a specific alternative. The following scenarios were evaluated:

1. only natural attenuation occurred (as would be the case in Alternative 1, No Action).
2. 5% of the hydrocarbon contaminant mass is removed.
3. 10% of the hydrocarbon contaminant mass is removed.
4. 25% of the hydrocarbon contaminant mass is removed.
5. 50% of the hydrocarbon contaminant mass is removed.
6. 75% of the hydrocarbon contaminant mass is removed.

Some uncertainty is associated with the model as a result of the assumptions inherent in the modeling process. For example, the model assumes that the decreases in contaminant mass presented above (5%, 10%, 25%, 50%, and 75%) were removed initially not over time as would be the case using product recovery wells. The estimated remedial timeframes developed using the TTCU model are included in Table 2-13 (page 53), the remedial alternatives summary table and in the following sections, as appropriate. Additional assumptions and the modeling results are presented in Appendix B of the FS.

2.11.3 Comparative Analysis

Following the detailed analysis of each individual alternative, a comparative analysis, focusing on the relative performance of each alternative against the nine criteria, was conducted. This comparative analysis can be found in Tables 4-1 (presented as Table 2-14 below) and 4-2 of the FS.

2.11.4 Narrative Summary

The section below presents the nine criteria and a brief narrative summary of the alternatives and the strengths and weaknesses according to the detailed and comparative analysis.

2.11.4.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through treatment, engineering controls, and/or institutional controls.

- Alternative 1 would not protect human health or the environment, in that the risk posed from contaminated media would not be reduced. The risk of potential exposure would continue from the LNAPL and the contaminated groundwater. Groundwater contamination would continue to migrate at present levels. This alternative does not confirm the apparent natural containment of the existing LNAPL and dissolved-phase plumes. Because groundwater monitoring is not included in this alternative, there would be no warning mechanism to assess the potential risks presented to human health and ecological receptors were the plumes to migrate. Effective management of groundwater use would not occur under this alternative.

- Alternative 9 would be protective of human health and the environment, and 5-year Reviews will also address continued protection of human health and the environment. LUCs/ICs will effectively ensure that groundwater is not used for human consumption and that future land use does not increase the risk of exposure to contaminants remaining on site. Monitoring will confirm that the dissolved-phase plume is contained and that groundwater containing COC concentrations exceeding ARARs is not discharging into the Shawsheen River. The physical removal of LNAPL during trench construction and subsequent LNAPL recovery from the wells and natural attenuation will, over time, permanently eliminate the source of groundwater contamination. Following the trench construction phase, the volume and toxicity of residual contaminants at the site (dissolved-phase plume and LNAPL) will continue to decrease due to natural attenuation and continued LNAPL recovery from the wells. Although this alternative does not provide any containment (reduction of mobility) of the existing dissolved-phase plume, historical data for the site indicates that the plume appears to have stabilized.

TABLE 2-14
Comparative Evaluation of Alternatives to Nine CERCLA Criteria

	Alt. 1	Alt. 9	Alt. 10	Alt. 11	Alt. 12
Evaluation Criteria	**No Action**	**Interceptor Trench with Passive Recovery Wells near Northern Boundary; Passive Recovery Wells throughout LNAPL Pool C; Monitoring and LUCs/ICs**	**Interceptor Trench with Passive Recovery Wells near Northern Boundary; ORC® Application in Trench; Passive Recovery Wells throughout LNAPL Pool C; Monitoring and LUCs/ICs; and Groundwater Containment/Treatment Contingencies**	**Interceptor Trench with Passive Recovery Wells near Northern Boundary; ORC® Application in Trench; In-Situ Oxidation of LNAPL Pool C; Monitoring and LUCs/ICs; and Groundwater Containment/Treatment Contingencies**	**Interceptor Trenches with Passive Recovery Wells near Northern Boundary and at 2 Hotspot Areas within LNAPL Pool C; ORC® Application in Trenches; Enhanced Recovery Wells at Non-hotspot Areas of LNAPL Pool C; Monitoring and LUCs/ICs; and Groundwater Containment/Treatment and VER Contingencies**
Relevant Section in Feasibility Study	4.3.2	4.3.3	4.3.4	4.3.5	4.3.6
Threshold Criteria					
Overall Protection of Human Health and the Environment	○	●	●	●	●
Compliance with ARARs	○	●	●	●	●
Primary Balancing Criteria					
Long-Term Effectiveness and Permanence	○	◖	◖	●	●
Reduction of Toxicity, Mobility, or Volume Through Treatment	○	◖	●	●	●
Short-Term Effectiveness	●	●	●	●	●
Implementability	●	●	●	●	●
Cost - Present worth ($)	59,000	1.36 million	1.38 million	2.04 million	1.57 million
Modifying Criteria					
State Acceptance	NC	NC	NC	NC	YES
Community Acceptance	NC	NC	NC	NC	YES

● Meets or exceeds criteria ○ Does not meet criteria NC = No Comment

◖ Partially meets criteria TBD = To be determined

- Alternative 10 would be protective of human health and the environment, and 5-year Reviews will also address continued protection of human health and the environment. LUCs/ICs will effectively ensure that groundwater is not used for human consumption and that future land use does not increase the risk of exposure to contaminants remaining on site. Monitoring will confirm that the dissolved-phase plume is contained and that groundwater containing COC concentrations exceeding ARARs is not discharging into the Shawsheen River. Also, contingency options would be in place to contain or treat contaminated groundwater on-site should groundwater monitoring indicate downgradient contaminant migration. The physical removal of LNAPL during trench construction and subsequent LNAPL recovery from the wells and natural attenuation will, over time, permanently eliminate the source of groundwater contamination. Following the trench construction phase the volume and toxicity of the residual contaminants at the site (dissolved-phase plume and LNAPL) will continue to decrease due to natural attenuation, the initial ORC® application, continued LNAPL recovery from the wells, and, if necessary, the implementation of one of the contingency options.
- Alternative 11 would be protective of human health and the environment, and 5-year Reviews will also address continued protection of human health and the environment. LUCs/ICs will effectively ensure that groundwater is not used for human consumption and that future land use does not increase the risk of exposure to contaminants remaining on site. Monitoring will confirm that the dissolved-phase plume is contained and that groundwater containing COC concentrations exceeding ARARs is not discharging into the Shawsheen River. Also, contingency options would be in place to contain or treat contaminated groundwater on-site should groundwater monitoring indicate downgradient contaminant migration. The physical removal of LNAPL during trench construction and subsequent LNAPL recovery from the wells in the trench, in-situ oxidation of the LNAPL in Pool C, and natural attenuation will, over time, permanently eliminate the source of groundwater contamination. Following the trench construction phase the volume and toxicity of the residual contaminants at the site (dissolved-phase plume and LNAPL) will continue to decrease due to natural attenuation, the initial ORC® application, continued LNAPL recovery from the wells in the trench, in-situ oxidation of LNAPL Pool C, and, if necessary, the implementation of one of the contingency options.
- Alternative 12 would be protective of human health and the environment, and 5-year Reviews will also address continued protection of human health and the environment. LUCs/ICs will effectively ensure that groundwater is not used for human consumption and that future land use does not increase the risk of exposure to contaminants remaining on site. Monitoring will confirm that the dissolved-phase plume is contained and that groundwater containing COC concentrations exceeding ARARs is not discharging into the Shawsheen River. Also, contingency options would be in place to contain or treat contaminated groundwater on site should groundwater monitoring indicate downgradient contaminant migration. The physical removal of LNAPL during trench construction and subsequent LNAPL recovery from the wells and natural attenuation will, over time, permanently eliminate the source of groundwater contamination. Following the trench construction phase the volume and toxicity of the residual contaminants at the site (dissolved-phase plume and LNAPL) will continue to decrease due to natural attenuation, the initial ORC® application, continued LNAPL recovery from the wells, and, if necessary, the implementation of one of the contingency options.

2.11.4.2 Compliance with Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA requires that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria, and limitations which are collectively referred to as "ARARs," unless such ARARs are waived under CERCLA section 121(d)(4).

Applicable requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address hazardous substances, the remedial action to be implemented at the site, the location of the site, or other circumstances present at the site. Relevant and appropriate requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law which, while not applicable to the hazardous materials found at the site, the remedial action itself, the site location or other circumstances at the site, nevertheless address problems or situations sufficiently similar to those encountered at the site that their use is well-suited to the site.

Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes or provides a basis for invoking a waiver.

- Alternative 1 would not achieve the chemical-specific ARARs for groundwater at the site because federal and state MCLs, federal MCLGs and state MCP Method 1 GW-1 standards will not be met in the short-term. There are no location-specific or action-specific ARARS for Alternative 1.

- Alternative 9 would, over time, meet chemical-specific ARARs by removing the LNAPL at the site which is the source of the groundwater contamination while natural attenuation eliminates the dissolved-phase plume. Standard construction mitigation measures would be taken to ensure that this alternative complies with all location-and action-specific ARARs, including federal Ambient Water Quality Criteria and the Massachusetts Surface Water Quality Standards. It is estimated that RAOs will be achieved by this alternative in less than five years in the areas containing LNAPL Pools A and B, whereas it will take more than 100 years for the contamination associated with LNAPL Pool C to be completely eliminated.

- Alternative 10 would, over time, meet chemical-specific ARARs by enhancing the biodegradation of the groundwater contaminants with ORC® and removing the LNAPL at the site which is the source of the groundwater contamination. Also, should downgradient monitoring indicate that containment or treatment of the dissolved-phase plume is needed, contingency options are in place to ensure that chemical-specific ARARs are met. Standard construction mitigation measures would be taken to ensure that this alternative complies with all location-and action-specific ARARs, including federal Ambient Water Quality Criteria and the Massachusetts Surface Water Quality Standards. It is estimated that RAOs will be achieved by this alternative in less than five years in the areas containing LNAPL Pools A and B, whereas it will take more than 100 years for the contamination associated with LNAPL Pool C to be completely eliminated.

- Alternative 11 would, over time, meet chemical-specific ARARs by enhancing the biodegradation of the groundwater contaminants with ORC® and removing the LNAPL at the site which is the source of the groundwater contamination. Also, should downgradient monitoring indicate that containment or treatment of the dissolved-phase plume is needed, contingency options are in place to ensure that chemical-specific ARARs are met. Standard construction mitigation measures would be taken to ensure that this alternative complies with all location-and action-specific ARARs, including federal Ambient Water Quality Criteria and the Massachusetts Surface Water Quality Standards. It is estimated that RAOs will be achieved by this alternative in less than five years in the areas containing LNAPL Pools A and B, whereas it will take between 50 and 100 years for the contamination associated with LNAPL Pool C to be completely eliminated.

- Alternative 12 would, over time, meet chemical-specific ARARs by enhancing the biodegradation of the groundwater contaminants with ORC® and removing the LNAPL at the site which is the source of the groundwater contamination. Also, should downgradient monitoring indicate that containment or treatment of the dissolved-phase plume is needed, contingency options are in place to ensure that chemical-specific ARARs are met. Standard construction mitigation measures would be taken to ensure that this alternative complies with all location-and action-specific ARARs, including federal Ambient Water Quality Criteria and the Massachusetts Surface Water Quality Standards. It is estimated that RAOs will be achieved by this alternative in less than five years in the areas containing LNAPL Pools A and B, whereas it will take between 25 and 50 years for the contamination associated with LNAPL Pool C to be completely eliminated.

2.11.4.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once clean-up levels have been met. This criterion includes the consideration of residual risk and the adequacy and reliability of controls.

- Alternative 1 does not provide long-term effectiveness and permanence for groundwater. There would be no containment or capture of the product pools or current groundwater contaminant plume. There is also no monitoring program to track potential migration of the groundwater plume toward the Shawsheen River.
- Alternative 9 would almost immediately substantially reduce the risk currently associated with the on-site LNAPL by removing the majority of LNAPL Pools A and B through excavation. Over time, due to continued recovery from the product recovery wells throughout the site and natural attenuation of both the residual LNAPL and dissolved-phase plume, the risk will be completely eliminated. It is estimated that RAOs will be achieved by this alternative in less than five years in the areas containing LNAPL Pools A and B, whereas it will take more than 100 years for the contamination associated with LNAPL Pool C to be completely eliminated.

  The product interceptor trench and the product recovery wells are expected to be effective and reliable over the long term if designed and constructed properly and routinely maintained. The LUCs/ICs and O&M program included in this alternative should ensure the long-term effectiveness and permanence of this alternative. Because some contaminants are initially left at the site, a review of site conditions would be required every 5 years until levels allow for unlimited and unrestricted exposure.

- Alternative 10 – In addition to what is discussed above for Alternative 9, Alternative 10 includes the long term containment/treatment of groundwater if necessary. It is estimated that RAOs will be achieved by this alternative in less than five years in the areas containing LNAPL Pools A and B, whereas it will take more than 100 years for the contamination associated with LNAPL Pool C to be completely eliminated.
- Alternative 11 – In addition to what is discussed above for Alternative 10, the in-situ oxidation wells installed under Alternative 11 are expected to be effective and reliable over the long term if designed and constructed properly and routinely maintained. It is estimated that RAOs will be achieved by this alternative in less than five years in the areas containing LNAPL Pools A and B, whereas it will take between 50 and 100 years for the contamination associated with LNAPL Pool C to be completely eliminated.
- Alternative 12 – In addition to what is discussed above for Alternative 10, the hotspot trenches and VER contingency included in Alternative 12 are expected to be effective and reliable over the long term if designed and constructed properly and routinely maintained. It is estimated that RAOs will be achieved by this alternative in less than five years in the areas containing LNAPL Pools A and B, whereas it will take between 25 and 50 years for the contamination associated with LNAPL Pool C to be completely eliminated.

Five year reviews would be necessary to evaluate the effectiveness of any of these alternatives because hazardous substances would remain on-site in concentrations above levels that allow unrestricted exposure and unlimited use.

2.11.4.4 Reduction of Toxicity, Mobility, and Volume

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

- Alternative 1 does not provide any reduction in toxicity, mobility, and volume through treatment. Alternative 1 could actually result in an increase in groundwater contaminant concentrations before a steady-state condition is achieved.
- Alternative 9 would provide a reduction in the toxicity and volume of the contaminants at the site by removing the majority of the LNAPL present at the site through excavation and the use of product recovery wells. Removal of this LNAPL will substantially decrease the volume of the source of the groundwater contamination and natural attenuation will, over time, eliminate both the residual LNAPL and dissolved-phase plume. Although this alternative does not provide any containment (reduction of mobility) of the existing dissolved-phase plume, historical data for the site indicates that the plume appears to have stabilized. This alternative meets the statutory preference for source area treatment.
- Alternative 10 – In addition to what is discussed above for Alternative 9, Alternative 10 includes a reduction in the toxicity and volume of contaminants at the site by applying ORC® into the trench excavation following removal of the petroleum-saturated soils to enhance the biodegradation of the contaminated groundwater found beneath the LNAPL Pools. In addition, Alternative 10 includes the potential to further reduce the volume and limit the mobility of contaminants through the implementation of containment/treatment contingencies.
- Alternative 11 – In addition to what is discussed above for Alternative 10, Alternative 11 includes a reduction in the toxicity and volume of contaminants at the site by treating the product and dissolved-phase contaminants at LNAPL Pool C through in-situ oxidation.

- Alternative 12 – In addition to what is discussed above for Alternative 10, Alternative 12 includes a reduction in the toxicity and volume of contaminants at the site by removing the majority of the LNAPL present at LNAPL Pool C through excavation and the use of enhanced product recovery wells. The toxicity and volume of contaminants at the site will also be reduced under Alternative 12 if the enhanced product recovery wells within LNAPL Pool C are converted and used as VER wells.

2.11.4.5 Short-Term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers and the community during construction and operation of the remedy until cleanup goals are achieved.

- Alternative 1 does not involve construction or site activities and, therefore, would produce no disturbance to the surrounding community and environment.

- Alternatives 9, 10, 11, and 12 would involve increases in air emissions, noise, and traffic in the area during the trench excavation and well drilling activities. A Site Specific Safety and Health Plan and standard construction mitigation measures (e.g., volatile emission control from stockpiled soil) will be implemented to minimize these impacts. Construction workers would be required to use personal protective equipment (PPE). Benefits from the remedial measures of these alternatives will begin to be realized upon completion of the product interceptor trench and installation of the product recovery wells. Overall these alternatives will be effective in the short-term. LUCs/ICs will also help ensure the short-term effectiveness of the remedy by preventing exposure to contaminants.

2.11.4.6 Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other government entities are also considered.

- Implementability is not applicable to Alternative 1 – No Action. Alternatives 9, 10, 11, and 12 are readily implemented. The trenching and well installation activities required by these alternatives are common construction activities that are technically simple/easy to implement (i.e., excavation and backfill, re-paving, and well installation). The application of ORC® is also technically simple to implement and the injection of the in-situ oxidation compound treatment would be conducted by a qualified subcontractor. A Site Specific Safety and Health Plan addressing the activities required by these alternatives will be developed and implemented to ensure that workers and the surrounding environment are not exposed to hazards. The services and materials required for implementation of these alternatives are readily available in the area. Standard trenching and other needed construction equipment and a drill rig will be used for these alternatives. Clean gravel is available locally to replace excavated petroleum-saturated soils.

- The long-term operation, maintenance and monitoring for Alternatives 9, 10, 11, and 12 are readily implemented. These services are readily available in the area and Hanscom AFB already has a contract in place for the operation, maintenance and monitoring of remedial actions. This contract is easily modified to include the requirements of the selected remedy, however future resources will be required. Air Force resources should be available for long-term operation, maintenance and monitoring requirements.

- LUCs/ICs are administrative measures and, since IRP Site 21 is on an active Air Force Installation, can easily be implemented.
- Five-year reviews would be required for all alternatives as long as contaminated groundwater remains at the site in concentrations above levels that allow unrestricted exposure and unlimited use. Five-year reviews are readily implemented, however future resources will be required. Hanscom AFB and EPA resources should be available for these reviews.

2.11.4.7 Cost

Under the NCP, cost is a primary balancing criterion. Total present worth costs for the five alternatives are:

- Alternative 1 - $59,000 (for 100 years at a 5% discount rate);
- Alternative 9 – $1.36 million (for 100 years at a 5% discount rate);
- Alternative 10 – $1.38 million (for 100 years at a 5% discount rate);
- Alternative 11 – $2.04 million (for 75 years at a 5% discount rate);
- Alternative 12 – $1.57 million (for 35 years at a 5% discount rate);

The total costs for the groundwater alternatives include capital costs, operation and maintenance costs, and a total present-worth cost. It should be noted that the capital costs for provisions incorporated in the trench design/construction under Alternatives 10, 11, and 12 for the contingency options have been included in the above costs. However, additional O&M costs, should one of the options be initiated, have not been included in the above since these would only be a small incremental addition to a support contractor's overall O&M requirements.

2.11.4.8 State / Support Agency Acceptance

The State has concurred with the selection of Alternative 12 (see Appendix G). Verbal comments received from the MA DEP RPM for Hanscom AFB are that Alternative 1 would not provide adequate protection of human health and the environment, Alternatives 9 and 10 would not achieve RAOs, and that Alternative 11, while it would achieve RAOs, would be more costly and take longer to achieve RAOs.

2.11.4.9 Community Acceptance

During the public comment period, the only comment, question, or opinion received from the community was a letter from a RAB member which expresses support for Alternative 12. Also see Appendix B, the Responsiveness Summary..

2.12 The Selected Remedy

2.12.1 Summary of the Rationale for the Selected Remedy

The selected remedy is Alternative 12 which consists of the installation of three interceptor trenches, implementation of LUCs/ICs, and monitoring. A full description of the preferred alternative is provided below. The selected remedy provides a means to contain/capture the site's product and dissolved-phase contaminants (VOCs and fuel compounds) and the monitoring will confirm that the groundwater contaminant plume is being remediated and/or contained and not adversely impacting the Shawsheen River. The preferred alternative was selected over the other alternatives because it is expected to achieve RAOs within a reasonable time frame (between 25 and 50 years), and is cost effective.

2.12.2 Description of Remedial Components

The selected remedial action for cleaning up OU-3/IRP Site 21 is Alternative 12. The principal components of this alternative include:

- Three (3) interceptor trenches with passive recovery wells, one main trench covering LNAPL Pools A and B near northern boundary of the site and two smaller trenches at hotspot areas within LNAPL Pool C;
- Network of active recovery wells in non-hotspot areas of LNAPL Pool C;
- Enhancement of biodegradation of dissolved-phased contaminants (VOCs and fuel compounds) by ORC® application in all trenches;
- Monitoring;
- Land Use Controls/Institutional Controls; and
- Groundwater Containment/Treatment and VER Contingencies.
- Five-year Reviews

2.12.2.1 Interceptor Trenches and Recovery Wells

The Air Force will submit for EPA/DEP comment and/or concurrence a Remedial Design (RD) and Remedial Action Work Plan for the construction of the OU-3/IRP Site 21 interceptor trenches and recovery wells. The main interceptor trench will be approximately 250 feet long, running east to west for approximately 100 feet through LNAPL Pool A (MWZ-9 and MWZ-10) and then turning southwest toward LNAPL Pool B for 150 feet ending approximately 50 feet southeast of ECS-33. Figure 2-11 presents the approximate location, length and width of the main interceptor trench. The location of this trench is currently paved and used for recreational vehicle and general purpose storage. The trench will be excavated to approximately 15 to 20 feet below ground surface (bgs). In the areas where LNAPL is present the trench will be approximately 30 to 40 feet wide in order to attempt to remove the majority of the LNAPL. The remainder of the trench will be only as wide as is necessary for safe sloping of the trench walls during construction.

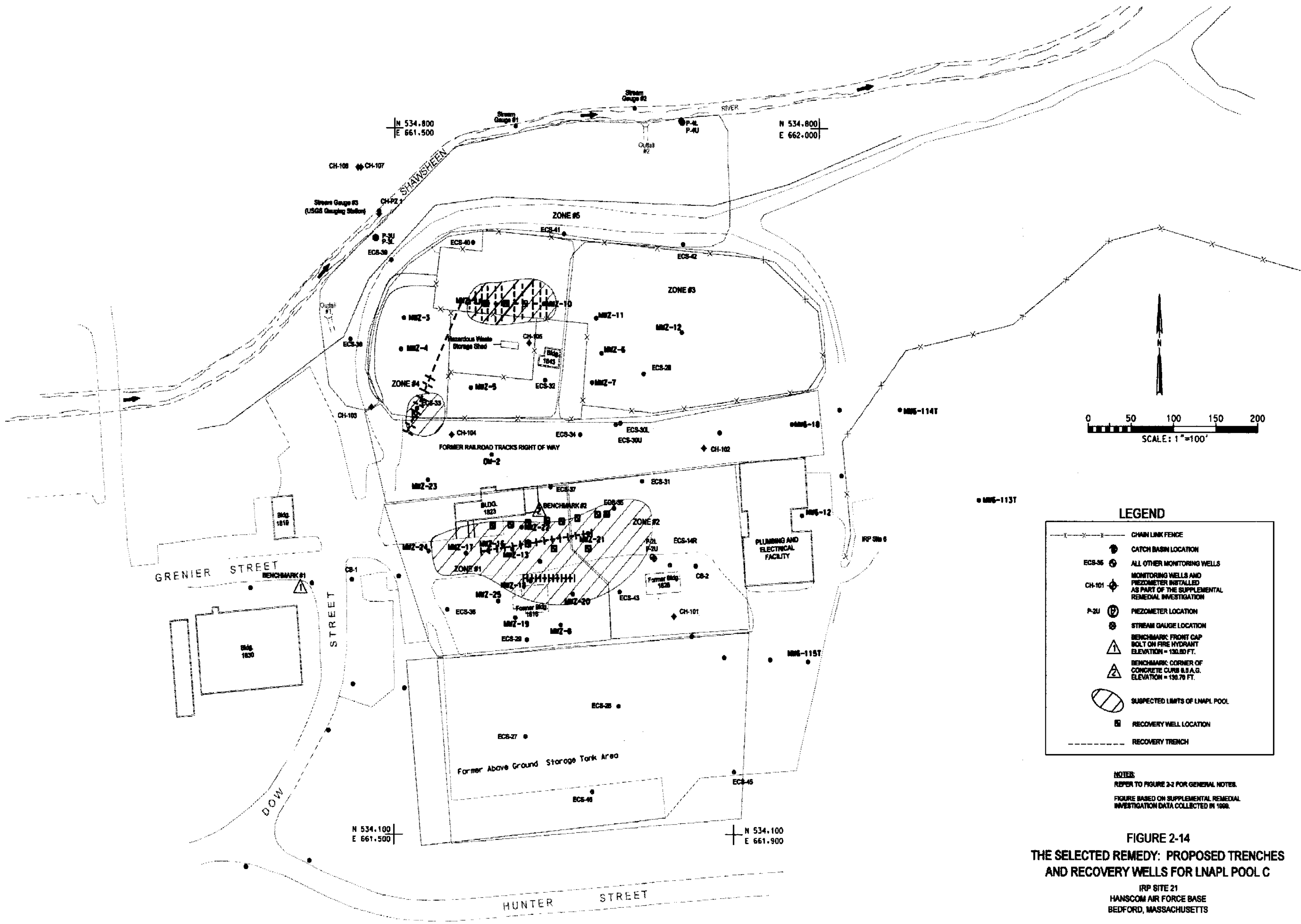
The water table varies between 11 and 17 feet bgs and approximately 6 feet of petroleum-saturated soil will be removed from the impacted capillary fringe area (or smear zone). A total of approximately 1,020 cubic yards of petroleum-saturated soil will be removed from the trench excavation and either recycled off-site at an asphalt batching facility or treated on-site for re-use. The specific soil disposal option will be determined during the remedial design phase. The portion of the trench below the water table will be backfilled with clean coarse gravel to create migration pathways within the trench to aid in product recovery. The remainder of the trench (above the water table) will be backfilled with native soil to the ground surface. A layer of geotextile material will be placed between the gravel fill and the native soil. The surface will be re-paved with asphalt once the trench is backfilled to the original ground elevation. Also, in addition to collecting residual LNAPL from Pools A and B, the trench near the northern boundary will intercept any migration of LNAPL from Pool C.

Interceptor trenches will also be installed at two "hot spot" areas within LNAPL Pool C. The first trench would run east to west for approximately 75 feet from MWZ-20 to MWZ-18 and the second trench would run east to west for approximately 150 feet from MWZ-21 to MWZ-16. Refer to Figure 2-11 for the planned location, length and width of the trenches. The location of the first interceptor trench is currently an access road paved with asphalt and the location of the second interceptor trench is an open grassy area. These trenches will be excavated to approximately 15 to 20 feet bgs and will be only as wide as is necessary for safe sloping of the trench walls during construction. The water table varies between 11 and 17 feet bgs and approximately 6 feet (approximately 250 cubic yards) of petroleum-saturated soil near the water table interface is anticipated to be removed. Disposal, recycling or treatment of the soil generated from these trenches will be as described above for the trench near the northern boundary.

Following removal of the petroleum-saturated soils and full excavation of the trenches, ORC® will be applied in the base of the excavations. The dissolved-phase contaminant concentrations are highest directly beneath the LNAPL pools, therefore, the ORC® will be applied to enhance the biodegradation of the groundwater contamination hot spots. Approximately 1155 pounds of ORC® (985 at LNAPL Pool A/B trench, 170 at LNAPL Pool C "hot spot" trenches) will be applied during the installation of the trenches.

Vertical passive product recovery wells will be installed in the trenches. The number of wells installed in the trenches will depend upon the success of the LNAPL removal during excavation, and will be determined through monitoring of residual LNAPL entering the trenches. It is estimated that four (4) recovery wells will be installed in the trench near the northern boundary and one (1) recovery well will be installed in each of the two trenches installed in LNAPL Pool C. LNAPL Recovery systems such as manually emptied recovery devices (bailers, oil absorbent materials, oliphatic filter recovery devices), will initially be used in the passive recovery wells. If the volume of LNAPL being recovered is significant then product-only pumps, belt skimming systems, or automatic emptying recovery devices may be installed in each of the passive product recovery wells.

As a contingency, the LNAPL recovery wells installed in the trenches will be designed so that they could be used for groundwater containment and/or treatment (pump and treat) if needed. The effluent from the pumps would be piped to the existing IRP Site 21 groundwater treatment system which consists of an oil-water separator, sand filter, and granular activated carbon canisters. Also as a contingency, the trench LNAPL recovery wells would be designed



LEGEND

- CHAIN LINK FENCE
- CATCH BASIN LOCATION
- ECS-35 ALL OTHER MONITORING WELLS
- CH-101 MONITORING WELLS AND PIEZOMETER INSTALLED AS PART OF THE SUPPLEMENTAL REMEDIAL INVESTIGATION
- P-2U PIEZOMETER LOCATION
- STREAM GAUGE LOCATION
- BENCHMARK: FRONT CAP BOLT ON FIRE HYDRANT ELEVATION = 130.80 FT.
- BENCHMARK: CORNER OF CONCRETE CURB 0.5 A.G. ELEVATION = 130.70 FT.
- SUSPECTED LIMITS OF LNAPL POOL
- RECOVERY WELL LOCATION
- RECOVERY TRENCH

NOTES:
REFER TO FIGURE 2-2 FOR GENERAL NOTES.
FIGURE BASED ON SUPPLEMENTAL REMEDIAL INVESTIGATION DATA COLLECTED IN 1999.

FIGURE 2-14
THE SELECTED REMEDY: PROPOSED TRENCHES AND RECOVERY WELLS FOR LNAPL POOL C
IRP SITE 21
HANSCOM AIR FORCE BASE
BEDFORD, MASSACHUSETTS

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for use as ORC® injection wells to create an ORC® treatment barrier injection to be used in lieu of the active pump and treatment system. The selection of the contingency to be implemented will be based on the evaluation of monitoring data.

Enhanced LNAPL recovery wells will be installed throughout the area of LNAPL Pool C not addressed by the two interceptor trenches described above. It is estimated that 10 recovery wells would be required. A pump would be installed in each well to lower the water table and draw in the product. The groundwater treatment system described above for the groundwater containment could be used. As a contingency, the product recovery well network within LNAPL Pool C would be designed so that they could be converted to VER wells should monitoring indicate that this technology may be more effective in reaching remedial goals. A treatment system would most likely be required for the off-gas of a VER system. This could be either vapor phase granular activated carbon canisters or a catalytic oxidizer. Hanscom has a catalytic oxidizer on-site that could be used if this contingency is implemented.

Following implementation of this alternative, an annual program would be established to operate, maintain, and monitor the trench and product recovery/groundwater containment systems. The Air Force will submit for EPA/DEP comment and/or concurrence the plan for the long-term operation and maintenance of the OU-3/IRP Site 21 remedial system. It is estimated that RAOs will be achieved by this alternative in less than five years in the areas containing LNAPL Pools A and B, whereas it is estimated to take 25 to 50 years for the LNAPL Pool C contamination to be effectively reduced. This estimated clean up time is based on the assumption that approximately 50% to 75% of the total contaminant mass is removed, 25% through hot-spot excavation in the short-term and 25% to 50% by the enhanced product recovery wells. Further details of the TTCU model and associated assumptions are included in the FS.

2.12.2.2 Groundwater Monitoring

A groundwater sampling and analysis program will be implemented to monitor progress towards achievement of RAOs. The program will include monitoring the reduction in the volume of LNAPL and the natural attenuation/natural containment of the LNAPL and dissolved-phase contaminant plumes. The Air Force will submit for EPA/DEP comment and/or concurrence a Long-Term Monitoring Plan (LTMP) and Quality Assurance Project Plan (QAPP) for OU-3/IRP Site 21. These will be incorporated in the existing Basewide QAPP. Monitoring results will be formally presented to support the 5-Year Reviews. In addition the method and means of informally submitting event report results will be concurred upon by the project team and documented in the QAPP. Also event report results will be presented to the RAB as they are received.

2.12.2.3 Land Use Controls/Institutional Controls

LUCs/ICs will be established at the site to ensure that groundwater is not used for human consumption and that future land use does not increase the risk of exposure to the contamination remaining on-site. Due to the nature and extent of the contaminants, the current and future land use, and since OU-3/IRP Site 21 is on an active Air Force Installation LUCs/ICs in terms of administrative mechanisms are considered acceptable measures to control exposure to on-site LNAPL and contaminated groundwater. LUCs/ICs have already been partially instituted in that IRP Site 21 is shown in the Hanscom Air Force Base General Plan (master plan) an area of the base with “Environmental Constraints” and base operating procedures as defined by Air Force Instructions (AFIs) requires that project planning documents (for both new construction and repair projects) be coordinated with the environmental office. These LUCs/ICs will be enhanced by amending the General Plan to add the specific environmental constraints (LUCs/ICs) that apply to IRP Site 21 and by issuing periodic Memorandums to Hanscom AFB project originators emphasizing the Air Force's requirement that project planning documents (for both new construction and repair projects) be coordinated with the environmental office. The specific LUCs/ICs that apply to OU-3/IRP Site 21 are:

- No drinking water wells allowed on the site and untreated groundwater recovered from the site can not be used for any purpose.
- Any digging, excavation, or groundwater use on the site must be approved by the base environmental office in writing and, once approved, be conducted in accordance with a site specific health and safety plan.
- No changes in the current land use of the site without the written approval of the base environmental office. The current land use is industrial and for the storage of recreational vehicles. Also EPA and MA DEP will be notified for consultation 45 days in advance of proposed land used changes, which are inconsistent with the land use assumptions or land uses described in this ROD.

The IRP Site 21LUCs/ICs will be implemented and enforced by Hanscom AFB in accordance with Air Force Instructions. Hanscom AFB will have ultimate responsibility for ensuring that these controls, as a component of the selected remedy, continue to be in place and are effective and protective of human health and the environment. In this regards the LUCs/ICs will be formally monitored and results documented by the base environmental office in normal operations, maintenance, and/or monitoring reports for the remedial action. Should the Air Force plan on transferring or leasing any property affected by OU-3/IRP Site 21, whether or not as a result of base closure, the Air Force will consult with USEPA and MADEP on the specific wording on groundwater and land use restrictions to be included in the documents evidencing the transfer or lease. If the property is transferred, or the lease allows capital improvements, a technical evaluation of the continued effectiveness and appropriateness of the remedy will be undertaken considering long-term monitoring results to date, the proposed land use, and the fact that the Air Force may no longer actively own or operate the property.

2.12.2.4 Five (5)-Year Reviews

Consistent with CERCLA Section 121©, 42 U.S.C. Section 9621©, the NCP, 40 CFR 300.430 (f)(4)(ii), the USAF will review the Remedial Action for OU-3/IRP Site 21 at least once every five years after the initiation of remedial action at the site to assure that human health and the environment are being protective by the Remedial Action being implemented. The Periodic Review Assessment Report will be in accordance with EPA guidance and the report will be submitted to EPA and the State for comment and/or concurrence. Five-year reviews will be conducted as long as any hazardous substances, pollutants or contaminants remain at the site (above levels that allow for unlimited use and unrestricted exposure) to assure that the remedial action continues to protect human health and the environment.

2.12.3 Summary of the Estimated Remedy Costs

A table detailing the selected remedy costs is presented in Appendix E. This remedy includes installation of three interceptor trenches with recovery wells, the removal and disposal of petroleum-saturated soils encountered excavating the trenches, and an initial application of ORC® to treat the dissolved-phase plume. Provisions will be incorporated into the design and construction of the recovery wells so that they could be readily converted to active pumping wells connected to the existing groundwater treatment system to contain and/or treat the dissolved-phase plume if needed. Provisions will also be incorporated into the design and construction of the recovery wells so that they could be used to inject additional ORC® to create a groundwater treatment barrier. This remedy also includes installation of enhanced product recovery wells in non-hotspot areas of LNAPL Pool C and the contingency to convert these wells to VER wells. Costs for the remedy also include the cost to operate, maintain, and monitor the remedial action including product disposal costs.

The capital cost for this alternative is approximately $1.02 million (low range costs). The annual operating, maintenance and monitoring costs will be approximately $28,000 (per year for 35 years) and the seven 5-year site reviews required over a 35-year period (mid range of time to complete) are estimated to cost $15,000 each. The total present worth cost of this alternative, based on a 5 percent discount rate, is approximately $1.57 million (low range of costs).

The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Major changes may be documented in the form of a memorandum in the Administrative Record file, an ESD, or in an amendment to this ROD. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

2.12.4 Expected Outcomes of the Selected Remedy

The primary expected outcome of the selected remedy is that the human health risks associated with the contaminated groundwater and LNAPL will be eliminated through the implementation of the selected remedy described above. Petroleum saturated soils will be removed during the installation of the trenches. Residual LNAPL not removed during construction will be contained, captured and removed through a network of active and passive recovery wells. Short term exposure to contaminants will be controlled through the use of the LUCs/ICs. Groundwater monitoring will confirm the effectiveness of the remedy in containing the LNAPL pools and dissolved-phase (VOCs and fuel compounds) groundwater contaminated plume from migrating to the Shawsheen River.

2.12.4.1 Cleanup Levels

Groundwater Cleanup Levels

Cleanup levels have been established in groundwater for all COCs identified in the baseline risk assessment as posing an unacceptable risk to either public health or the environment. Table 2-15 summarizes the cleanup levels for carcinogenic and non-carcinogenic COCs in groundwater. These cleanup levels have been set based on the chemical-specific ARARs for OU-3/IRP Site 21 consisting of federal drinking water standards (i.e., MCLs and non-zero MCLGs), state drinking water standards (i.e., MCLs) and state groundwater risk characterization standards (i.e., MCP Method 1 GW-1 standards). These cleanup levels were selected since the groundwater beneath and directly downgradient to OU-3/IRP Site 21, and beneath and directly downgradient to the Hanscom AFB/Hanscom Field NPL Site as a whole, has been designated as GW-1 (i.e., as a potential future drinking water supply) under state law by means of a Town of Bedford Aquifer Protection District by-law that was enacted through a process authorized by MADEP and implemented through the state regulations (MCP).

MCLs shall constitute the final groundwater cleanup levels for this ROD. Newly promulgated ARARs and modified ARARs which call into question the protectiveness of the remedy and the protective levels determined as a consequence of the risk assessment of residual contamination, also must be met at the completion of the remedial action. At OU-3/IRP Site 21 cleanup levels will be met in groundwater throughout the site and will be demonstrated through monitoring. USAF has estimated that the cleanup levels will be obtained between 25 and 50 years after the selected remedy is put in place.

2.13 Statutory Determinations

The selected remedy will provide protection of human health and the environment by reducing the overall extent of the LNAPL pools and dissolved-phase (VOCs and fuel compounds) groundwater contaminated plume via a reduction in the contaminant mass. The site risks associated with exposure to groundwater will be reduced through the use of the LUCs/ICs.

The remedial action selected for implementation at OU-3/IRP Site 21 is consistent with CERCLA and, to the extent practicable, the NCP. The selected remedy is protective of human health and the environment, will comply with ARARs and is cost effective. In addition, the selected remedy utilizes permanent solutions including groundwater treatment, LNAPL recovery and excavation of petroleum saturated soils, and alternate treatment technologies including groundwater treatment with ORC® to the maximum extent practicable, and satisfies the statutory preference for treatment that permanently and significantly reduces the mobility, toxicity or volume of hazardous substances as a principal element.

2.13.1 The Selected Remedy is Protective of Human Health and the Environment

The remedy at this site will adequately protect human health and the environment by eliminating, reducing or controlling exposures to human and environmental receptors through contaminant removal and treatment, engineering controls, land use controls and institutional controls. More specifically, for groundwater, this remedy protects human health and the environment by removing the LNAPL, containing/capturing/treating dissolved-phase contaminants (VOCs and fuel compounds) and preventing contaminant migration to potential exposure points. The interceptor trenches will collect the LNAPL at the site for removal, and will contain dissolved-phase contaminants in groundwater if the groundwater plume is found to be migrating towards the Shawsheen River. In addition, during construction of the interceptor trenches much of the contaminant mass will be removed (i.e., petroleum saturated soils from the smear zone), and contaminant mass will be reduced through treatment of the groundwater with ORC®. The implementation of LUCs/ICs will serve to control access to and exposure to the contaminated media whilst the remedy operates to meet the cleanup goals and ARARs. Monitoring groundwater within OU-3/IRP Site 21 will serve as an early warning system. Implementation of the selected remedy will not pose any unacceptable short-term risks or cause any cross-media impacts.

Table 2-15
Groundwater Interim Remediation Goals (RGs) in Parts Per Billion (ppb)
IRP Site 21, Hanscom Air Force Base
Bedford, Massachusetts

Constituent	MCL	MCP Method 1 Groundwater Standards			Risk-Based Remediation Goals	
		GW-1	GW-2	GW-3	THQ = 0.07	TR = 10-6
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
1,4-Dichlorobenzene	75	5	30000	8000	14	1
1,2-Dichlorobenzene	600	600	10000	8000	41	
1,2,4-Trichlorobenzene	70	70	10000	500	4	
Vinyl chloride	2	2	2	40000		0
cis-1,2-Dichloroethene	70	70	30000	50000	5	
1,2-Dichloropropane	5	5	9	30000	1	1
trans-1,3-Dichloropropene	NA	1	5*	2000	0	0
Tetrachloroethene	5	5	3000	5000		1
Trichloroethene	5	5	300	20000		
Benzene	5	5	2000	7000	2	1
Toluene	1000	1000	6000	50000	99	
Ethylbenzene	700	700	30000	4000	46	
n-Propylbenzene	NA	NA	NA	NA	4	
1,3,5-Trimethylbenzene	NA	NA	NA	NA	22	
1,2,4-Trimethylbenzene	NA	NA	NA	NA	21	
sec-Butylbenzene	NA	NA	NA	NA	4	
Naphthalene	NA	20	6000	6000	16	
Benzo(a)anthracene	NA	1	NA	3000		0
Benzo(b)fluoranthene	NA	1	NA	3000		0
Benzo(a)pyrene	0	0	NA	3000		0

Notes:
MCL from USEPA Drinking Water Regulations and Health Advisories, EPA 822-B-96-002, October 1996.
MCP Method 1 Groundwater Standards (310 CMR 40.0974(2))
THQ - target hazard quotient. Because there are 14 noncarcinogenic COCs, THQ of 0.07 was used for each constituent. Each COC is assumed to contribute 1/14th of the acceptable total THQ of 1.0.
TR - target risk
*GW-2 Standard applies if contamination is found within 30 feet of an existing occupied building or structure, and the average annual depth to groundwater in that area is 15 feet or less.
Shaded cells indicate which standard established the PRG for the compound.

2.13.2 The Selected Remedy Complies With ARARs

The selected remedy will comply with all federal and any more stringent state ARARs that pertain to the site. ARARs for OU-3/IRP Site 21 include both federal and state requirements and are listed below and presented in more detail in Appendix F. A discussion of why these requirements are applicable or relevant and appropriate may be found in the FS Report in Section 2.3. Federal requirements include:

1. Safe Drinking Water Act MCLs (40 CFR 141.11-141.16) (USEPA 1999)
2. Safe Drinking Water Act MCLGs (40 CFR 141.50-141.51)
3. Fish and Wildlife Coordination Act (16 USC 661 et seq.)
4. Protection of Floodplains, Executive Order 11988 (40 CFR 6, Appendix A)
5. Federal Ambient Water Quality Criteria (AWQC), 33 U.S.C 1314(a); (40 CFR Part 122.44)
6. Clean Water Act National Pollutant Discharge Elimination System (NPDES) Regulations (40 CFR 122-125 and 131)
7. Federal Ambient Water Quality Criteria (AWQC), 33 U.S.C 1314(a); (40 CFR Part 122.44)
8. RCRA 40 CFR Part 264, Subpart F – Releases from Solid Waste Management Units (40 CFR 264.90 – 264.101 and 265.90 – 265.94)
9. Federal Safe Drinking Water Act Underground Injection Control Program (UIC) Subparts C, D and E (40 CFR 144.21 – 144.55)
10. RCRA Identification and Listing of Hazardous Wastes (40 CFR 261.24)
11. RCRA Standards Applicable to Generators of Hazardous Waste (40 CFR Part 262)
12. RCRA Air Emission Standards for Equipment Leaks (42 USC 6924, 40 CFR 264, Subpart BB)

State requirements include:

1. Massachusetts Drinking Water Standards (310 CMR 22.00)
2. Massachusetts Contingency Plan Method 1 GW-1 Standards (310 CMR 40.0974)
3. Massachusetts Endangered Species Act, 321 CMR 10.00, (MGL c. 131A)
4. Clean Waters Act – Surface Water Discharge Permit Program (314 CMR 3.00; MGL c. 21 Sections 26-53)
5. Massachusetts Surface Water Quality Standards (314 CMR 4.05(3)(b)5-8; MGL c.21 Sections 26-53)
6. MA HWMR Groundwater Protection (310 CMR 30.660-30.679)
7. Massachusetts Groundwater Discharge Permit Program (314 CMR 5.00; MGL c.21 Sections 26-53)

8. Massachusetts Application of Remedial Additives (310 CMR 40.0046)
9. Massachusetts Standards for Analytical Data for Remedial Response Action, Bureau of Waste Site Cleanup Policy 300-89.
10. Massachusetts Underground Injection Control (UIC) Program (310 CMR 23.01-23.11)
11. Massachusetts Hazardous Waste Management Rules (HWMR), Use and Management of Containers, 310 CMR 30.689; Storage and Treatment in Tanks, 310 CMR 30.699
12. Massachusetts HWMR, 310 CMR 30.300-30.371, Requirements for Generators
13. Solid Waste Disposal Laws (MGL c. 21H, MGL c. 111, 150A-150A ½, 310 CMR 19.100-151
14. Massachusetts Air Pollution Control Regulations (MGL c.111 Sections 142A-142M, 310 CMR 7.09 and 7.18)

2.13.3 The Selected Remedy is Cost-Effective

In the USAF's judgment, the selected remedy is cost-effective because the remedy's costs are proportional to its overall effectiveness (see 40 CFR 300.430(f)(1)(ii)(D)). This determination was made by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria (i.e., that are protective of human health and the environment and comply with all federal and any more stringent ARARs). Overall effectiveness was evaluated by assessing three of the five balancing criteria -- long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness, in combination. The overall effectiveness of each remedy then was compared to the remedy's costs to determine cost-effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence represents a reasonable value for the money to be spent. Costs for the selected remedy are presented in Appendix E.

2.13.4 The Selected Remedy Utilizes Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

Once the USAF identified those alternatives that attain the ARARs and that are protective of human health and the environment, USAF identified which alternative utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. This determination was made by deciding which one of the identified alternatives provides the best balance of trade-offs among alternatives in terms of: 1) long-term effectiveness and permanence; 2) reduction of toxicity, mobility or volume through treatment; 3) short-term effectiveness; 4) implementability; and 5) cost. The balancing test emphasized long-term effectiveness and permanence and the reduction of toxicity, mobility and volume through treatment; and considered the preference for treatment as a principal element, the bias against off-site land disposal of untreated waste, and community and state acceptance. The selected remedy provides the best balance of trade-offs among the alternatives.

Using the Time to Cleanup Model, estimates were calculated for how long it would take to eliminate the risks to human health and the environment posed by the site's contaminants under each alternative. Alternatives 11 and 12 were estimated to eliminate the risks within an acceptable time frame (<100 years). In addition, the preferred alternative (Alternative 12) uses the most aggressive product removal methods and therefore was estimated to reduce contaminant volume in the shortest timeframe. Between the two alternatives that satisfied the threshold criteria, Alternatives 11 and 12, Alternative 12 also had a lower total present worth cost.

2.13.5 Five-Year Reviews of the Selected Remedy are Required

Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, a review will be conducted by the Air Force each five years after initiation of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. The Periodic Review Assessment Report will be in accordance with EPA guidance and the report will be submitted to EPA and the State for comment and/or concurrence. Five-year reviews will be conducted as long as any hazardous substances, pollutants or contaminants remain at the site (above levels that allow for unlimited use and unrestricted exposure) to assure that the remedial action continues to protect human health and the environment.

2.14 Documentation of No Significant Changes

Hanscom AFB presented a proposed plan, *Proposed Plan for Hanscom AFB Operable Unit 3/IRP Site 21*, CH2M HILL, July 2001, discussing the selected remedy. The preferred alternative was the installation of interceptor trenches and recovery wells at both the northern boundary of the site and in LNAPL Pool C in the southern sector of the site to provide the means to contain/capture the site's product and dissolved-phase contaminants (VOCs and fuel compounds). This alternative will include the removal and disposal of petroleum saturated soils from the trench excavation and the application of ORC® into the open trenches. Additional management of contaminants includes monitoring and land use controls/institutional controls. Hanscom AFB reviewed all written and verbal comments submitted during the public comment period. It was determined that no significant changes to the remedy, as originally identified in the proposed plan, were necessary.

2.15 State Role

The MADEP has reviewed the various alternatives and has indicated its support for the selected remedy. The State has also reviewed the Remedial Investigation, the Supplemental Remedial Investigation including the Risk Assessment, and the Feasibility Study to determine if the selected remedy is in compliance with applicable or relevant and appropriate State environmental and facility siting laws and regulations. The MADEP concurs with the selected remedy for OU-3/IRP Site 21. A copy of the declaration of concurrence is attached as Appendix G.

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